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THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1935

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NATIONAL MUSEUM OF VICTORIA

Our Pulsating World

The Influence of Earth Movements on Human Development[1]

By

A. N. LEWIS, M.C., LL.D.

(Portion of a lecture delivered at the presentation of the Medal of the Royal Society of Tasmania to the author)

GEOPHILOSOPHY

It is very usual for people to say 'Things are not what they used to be—even the climate is changing.' Of course it is. Everything is changing. Change is the order of nature. Nevertheless, change and development in the vegetable and animal kingdom are very largely the result of changes on the face of the earth. This change is so gradual as to be imperceptible to human senses, but what we call 'the solid earth' is really a pulsating body, growing, discarding, developing almost like a living thing, and the results of each period of development lie around us, if only we will look.

We can now see an underlying principle or guiding influence emerging from the bewildering discoveries of science. This is the nature of the Earth itself—the mother of all living things, and, if we are to lead a really full life, we must be able to picture the Earth in its relationships to ourselves. After all, is this not true philosophy—the science of being—for out of the Earth all things have their being. Looking beyond individuals to species and wider groups of living things, we can see that they have not *grown*, but rather have been *brought up*. If our philosophy stops short of bestowing a consciousness on the Earth, that is only because our ideas are restricted by language. The result we see around us is in no way different from what it would be were we to accept the Earth as a conscious individuality. The conscious direction given by the human mind is, after all, a physical phenomenon, the result of influences dating back for hundreds of millions of years. The control of life by the Earth is also a physical phenomenon emanating from the same influences and, ultimately, the same force as the human mind. If we are to live fully we must have a philosophy of life. To serve us truly, our philosophy must be based on truth. The knowledge of the being of the world as a planet—what I have called *Geophilosophy*—must form the basis of our personal philosophy of our own life.

[1] This lecture may be regarded as a summary of present geographical knowledge for the benefit of Tasmanian students, rather than as an original contribution to scientific knowledge of any general interest beyond Tasmania.—A.N.L.

Yet how much does the average person care? Of the thousands who daily look at Mount Wellington from our city streets, how many ever think, *how, when, why,* it stands as we see it. It is a real tragedy that there are not ten people amongst those who have ever seen it who have tried to fathom the riddle of Hobart's Sphinx. How much more true is this of our conception of the world as a whole. Unless you can hold the Earth in your hand and understand it as the living, pulsating, and dominating thing it is—can you call yourself a philosopher? The first lesson of science is proportion. When you can comprehend the sun as an infinitesimal atom of the universe rushing through space at 200,000 miles an hour, now twenty-five billion miles from its nearest neighbour, but nevertheless a member of the larger atom of creation—when you can comprehend the influence of the Earth, a minor planet upon the atoms which in their organized existence make up the microscopic creatures which live on its surface—then you will have no unduly exaggerated notion of the importance of your own daily troubles.

The Earth

Before we can form a reasonable appreciation of events on the surface of the earth, we must have an accurate idea of the nature of our earth as a planet. Modern science has gone a long way towards providing this. In the first place, the world is not a thin crust adjusting itself to a cooling interior. We have learnt much since Kelvin used the simile of the baked apple. For one reason, amongst many, solid rock (unlike ice) sinks in its molten equivalent, and, in cooling, the core of the earth solidified first. We must regard the earth as a mass of rock groups of varying nature, with the heaviest at the core, all under enormous pressure, which increases with depth, and all mutually supporting each other in a condition of adjustment, held together by a definite attraction and by great pressure from outside.

The mass of the earth is composed of a few common and many rare elements, which combined in the original cooling to form definite minerals. The minerals which consolidated first and heavy minerals consolidating somewhat later tended to congregate as a core. The earth in this way is now seen to consist of concentric rings of matter which increase in density inwards. The inner core consists of a substance resembling nickel steel (called by Suess *Nife*), with gold, platinum, and other heavy metallic elements. Outside this is a ring of iron silicates *(Sife)*, divided into eclogite and pallassite—our heaviest known rocks. Next come the ferro-magnesium silicates, or basalt rocks *(Sima)*, and, last of all, the alumina silicates, or granite rocks *(Sial)*. It will be noticed from Fig. 1 that the *Sial* is not continuous. Over the Atlantic it is very thin, and it is ruptured over the Pacific, Indian, Arctic, and Southern Oceans.

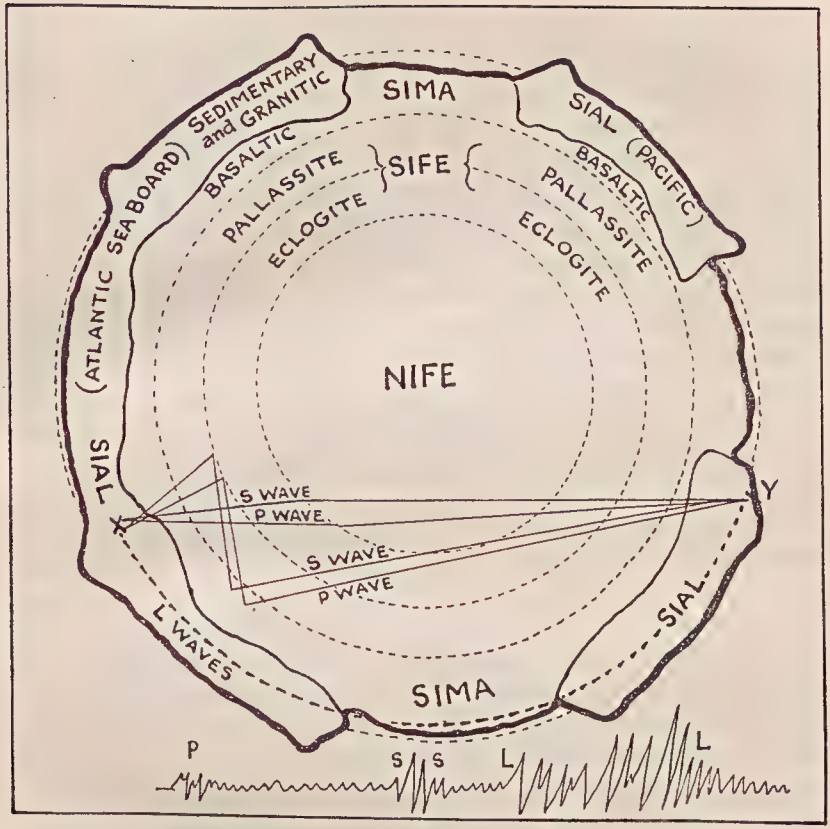

Fig. 1.—Diagrammatic Representation of the Interior of the Earth.

This shows the density zoning from the nickel-iron core (s.g. 7·5) to the basaltic layer (s.g. 3·5), with the light acid or granitic layer (s.g. 2·5) forming the land masses 'floating' in the basaltic layer. The Atlantic Ocean covers a depression in the granitic layer, and the other oceans cover gaps in the layer, having floors of the basaltic layer.

(NOTE.—The diagram is not intended to represent the reflexion and refraction angles of the earthquake waves, which are greatly exaggerated.)

The study of the behaviour of the seismograph when recording major earthquakes has provided a means whereby the nature of the interior of the earth may be studied. It is very noticeable that the instrument commences its record by a number of short, sharp vibrations (*P* waves). After an appreciable time a few waves of greater intensity are recorded (*S* waves). These gradually decrease until they are replaced by waves of maximum intensity (*L* waves), which reach a climax, and then decrease regularly until the instrument ceases to record. The earthquake shock produces wave motions similar to any other wave, and when such an

impulse passes from one medium to another of a different density the original wave is split, portion being reflected back into the original medium, and portion passes to the new medium, but with a slight change in direction (provided, in both cases, the angle at which the wave meets the dividing line permits this). The *P* waves are those which pass direct from the epicentre of the earthquake *X* to the instrument *Y*. The *S* waves are reflected waves, of which there may be many, as several media are traversed. The *L* waves are those which travel round the circumference of the earth. When the epicentre has been located, and the distance thence to the instrument has been accurately measured, the time interval between the reception of the *P*, *S*, and *L* waves provides a means of testing the varying density of the rock through which the waves have passed. The rate of passage is constant, and is now known with great accuracy, and from the results of extensive researches it has been possible to determine the density, and consequently the nature, of the rocks composing the interior of the earth.

It is well established that the interior cores are very solid, more so than the best steel. They are certainly at a high temperature, so hot that they would fly into gases if at the surface, but they are under such compression that they maintain their rigidity. However, if the pressure is released, they will fuse, and they will yield to the slightest variation of pressure. The position is that the earth is only stable while the pressure from all parts of the surface on the interior is the same. When this varies, the interior yields, with the results to be described later. Thus, the lighter *Sial* may be regarded as floating on the *Sima*, somewhat as icebergs float on water. It cannot sink, as it is lighter, but it can squeeze portion of the *Sima* out between spaces in the disjointed blocks of *Sial*.

These blocks of *Sial* are the continents, and the spaces between them are filled with the lightest and most fluid constituent of the earth (water). These spaces represent the oceans, except the Atlantic, which is a deep trough in the *Sial*. The framework, or shields, of these continents were formed from the original *Sial* masses on the original cooling of the world. All that primordial material has now disappeared, but we can trace where it originally stood. This was the position when the world had first cooled sufficiently to allow water to remain on the surface. The surface was then covered by some 12 to 14 blocks of differing density, but all exerting an equal pressure on the interior, the difference in density being compensated by difference in height above the average surface. These blocks therefore interlocked and mutually supported each other, much as the stones of an arch.

But from the very first another factor was at work which tended to upset this adjustment—isostatic adjustment as it is called.

That factor was erosion. All day and every day the influence of weather and running streams is at work on every part of the surface of the globe which is not protected by the sea. The effect of this is that the lighter segments are continually being worn away and made lighter. All this eroded material is carried out to sea and deposited on the heavier segments, which are continually being made heavier. In the course of time this upsets the adjustment. The heavier segments cannot sink, in the normal sense of the term, because they are supported by still denser layers below, but they exert a cumulatively greater pressure on the plastic interior, and squeeze underlying material in the direction of least resistance—under the lighter segment alongside. That imparts a constant upward movement to the land, which in turn adds erosive power to its streams, and increases the load which is bearing down the neighbouring ocean floor. So we have a constant cycle of movement, as shown in Fig. 2.

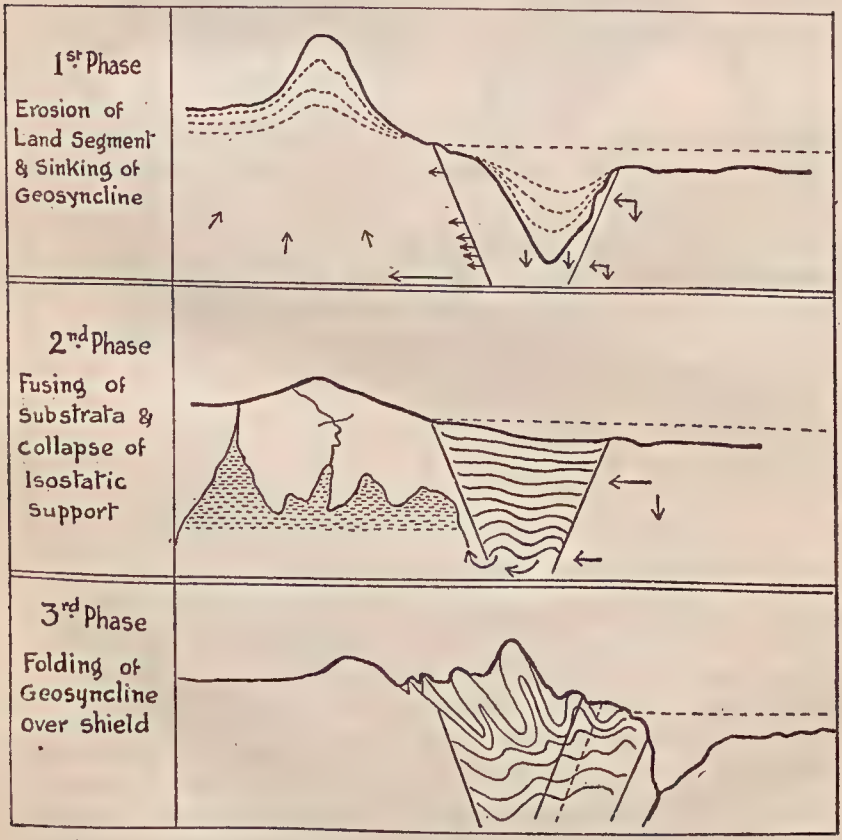
1st Phase
Erosion of Land Segment & Sinking of Geosyncline
2nd Phase
Fusing of Substrata & Collapse of Isostatic Support
3rd Phase
Folding of Geosyncline over Shield

Fig. 2.—Diagrammatic Representation of an Epiorogenic Cycle.

However, since the earth is a sphere, any surface area must form a wedge downwards. Therefore any sinking generates pressure on the boundaries of the sinking segment. The land side of the wedge presents the less resistance, as it is less dense than the ocean segment on the opposite side. And here also the sediments are thickest and of a nature less able to resist pressure. As the process continues, the newly deposited sediments are squeezed up and over

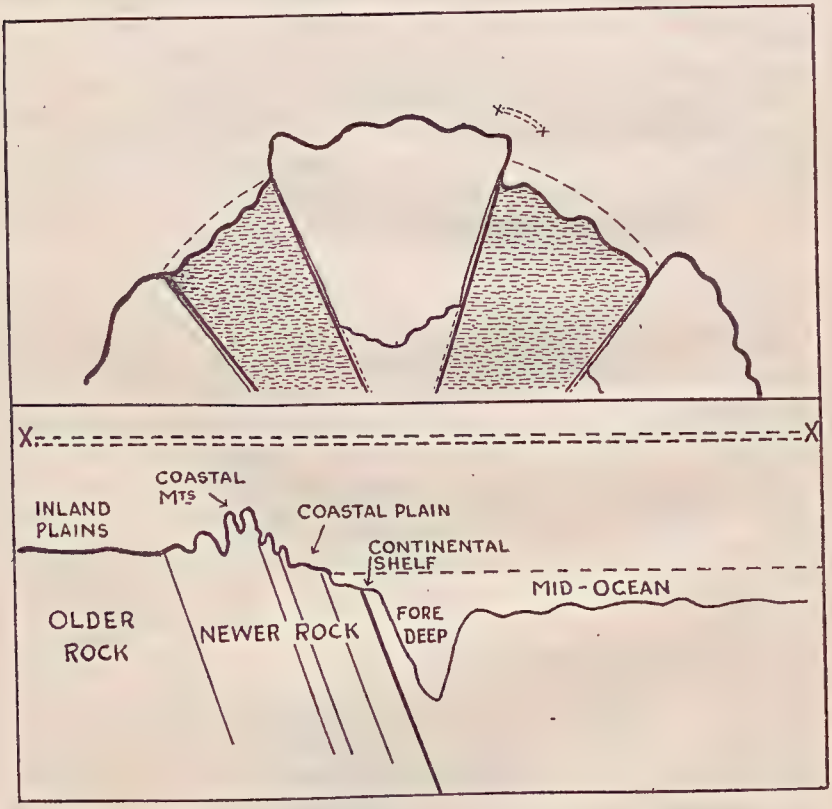

Fig. 3.—Diagrammatic Representation of the Process of Continent-Building.

The upper portion illustrates the effect of the sinking of a segment of the globe. X = = = = = = X is enlarged in the lower portion of the diagram, and illustrates the typical margin of the continents.

the margin of the older land mass, and so, in addition to the slow continental uplift, we get a more rapid movement, resulting in the formation of chains of folded mountains along the continental sea-board, with festoons of islands representing a continuation of the process out to sea. (Fig. 3.) All this generates heat from friction, and much of the underlying rock fuses and forms large

deep-seated reservoirs of molten rock. This cannot withstand pressure as solid rock can, and the continental mass, in such circumstances, tends to collapse. This happening throws additional stresses on the wedge of newly formed sediments, and completes the process of the formation of great mountain cordilleras like the Alps, Himalayas, Rockies, Andes, &c. (Fig. 3.) It is often accompanied by intense volcanic activity.

The process continues until the pressure is mutually adjusted, and heat is lost by radiation from volcanic extrusions. Weather then commences again to destroy this adjustment. Rock masses are very rigid, and it takes a very considerable difference in stress to overcome this initial resistance. When, however, it is overcome a major world revolution occurs.

Radio-Activity

This cycle of adjustment, erosion, uplift, squeeze, collapse, and overfolding of a new zone of rock does not explain everything. There is a further, major pulsation caused by an inherent property of the earth. It is now known that the sun is not getting appreciably cooler. Neither is the earth. This is due to the existence throughout the matter of the sun and its planets of elements possessing what is known as radio-active properties. There are some 30 of these, grouped in two families—*Uranium* and *Thorium*. These minerals are constantly breaking down by the emission of electrically charged atoms of helium and other rays, which are ejected explosively with velocities of thousands of miles a second. You can see the result by examining a luminous watch with a magnifying glass in the dark. If the parent uranium constantly gives off helium, something else must remain. There are, in fact, eight stages, the third of which is radium after three atoms of helium have been discharged. After eight atoms the mineral becomes stable as, chemically, lead (*Ur pb* or *Th pb*). This change cannot be hastened or retarded. The bombardment produces heat and also chemical change in surrounding rock. You all know the possibilities in this direction of radium.

Two results flow from this attribute of our planet. First, the constant bombardment of surrounding rock generates heat. This is the heat of the earth and of the sun—the difference bearing an exact ratio to the differing proportions of radio-activity in each. The cumulative effect is enormous, particularly as slightly radio-active minerals, such as zircon and orthoclase, are widely distributed, and the simple fact is that the earth is not cooling appreciably. The second result is that an accurate time-scale has been worked out from these minerals. The change is constant. It starts when the rock in which the mineral is found crystallized from

a molten magma. The proportion of daughter elements to the parent uranium or thorium can be measured with great accuracy, and the date of the formation of the rock in question can be ascertained almost to a year.

History

We now know that the sun's heat is not due to combustion—it would not last for 1000 years if such had been the case. We also know that the climate of the earth was much as we now know it, 600 million—perhaps 1600 million—years ago. The fact is that the energy stored in the atoms which make up matter is sufficient for every requirement.

Astronomical data show that the sun has been shining much as it is to-day for 8 billion years, and that the planets separated about 3000 million years ago. The cause of this separation was, most probably, the near approach of a star which raised a tide on the face of the sun, some of which separated and consolidated into nuclei we now call planets. The moon must have separated from the earth at the same time. This date, 3000 million years, accords with astronomical, physical, and radio-active evidence.

Geological history is conventionally divided into certain epochs recognizable as lasting from one major orogenic revolution to the next, and marked by a distinctive grouping of forms of life. In the geological sense, these have been true revolutions—slow to the degree of imperceptible, but when completed, final and terminating a distinct phase of history. Some forms of life have persisted since the earliest times, but in each epoch there has spread over the world a group of more highly specialized forms, which have become extinct at the beginning of the next revolution owing to their inability to adapt themselves to the changed conditions.

Traditionally, geological history commences with the Cambrian period. Radio-active evidence places the middle of this period as 600 million years ago. But we now know that there was a period of 1000 million years prior to that when the world was subject to the same geographical influences as we now know. Therefore we have a period from the earliest times to the time when water was able to condense of some 1400 or 1500 million years, a period equal to the time which has elapsed between that date and the present time. Between the time when water commenced to run and the earliest records of geological history, vaguely termed the Pre-Cambrian, there elapsed a period of 1000 million years, far longer than the whole period about which we know anything. Geology, therefore, can at present only deal with one-fifth of the earth's history, and we must still rely on physics and astronomy for the earlier four-fifths. The principal reason for this is the course of earth movements already mentioned, whereby the older

rocks have been worn away long since. The Cambrian dawned with a fully developed and highly organized life, which was probably developing since, or even before, water commenced to flow 1000 million years earlier. By Cambrian times the animal kingdom had developed up to the Crustacea, and the vegetable to highly organized algae. From that date earth history shows a reasonably complete record, although details of geography cannot be confidently traced until we reached the Tertiary period. Some of the more important dates in the earth's history are given in the following table:—

Age of the Sun: 8,000,000,000,000 years		
Age of the Earth: 3,000,000,000 years		
Probable Future Life of Earth: 7,500,000,000,000 years		
Consolidation of Planet—Period of Density—Stratification—Cooling—Crinkling, &c.: 3,000,000,000 to 1,600,000,000 years		
Commencement of Erosion and Deposition of Earliest Sedimentary Rocks: 1,600,000,000 years		
Age of Oldest Rocks now remaining—Geological History begins: 640,000,000 years		
CAMBRIAN	600,000,000	Life well developed
DEVONIAN	390,000,000	Vertebrate animals and land plants first appeared
PERMIAN	220,000,000	Existing plant phyla and animal phyla up to Reptiles are represented
CRETACEOUS	100,000,000	Mammals well established
TERTIARY	100,000,000 to 1,000,000	Primates first appeared
PLEISTOCENE	1,000,000 to present day	Man first appeared
Pre-Glacial *Günz* *Riss-Würm* *Würm*	1,000,000 800,000 250,000 100,000 40,000	Pithecanthropus Negrito Neolithic Aryan Bronze Age (Azilian)

The succession of events as disclosed by this history is as follows: After a very long period, marked by a fairly uniform grouping of forms of life, erosion produces a flat, level world, with deep

accumulations of sediments in long troughs off the edge of the continents. The general temperature gradually rises under the influence of radio-active properties in the earth's crust, and this is accompanied by a degree of fusion of the substrata allowing the surface to adjust with great delicacy. Coal measures, often thousands of feet thick, show an adjustment to water-level so perfect that the addition of one-eighth of an inch of sand depresses the level by a corresponding amount. This phase is accompanied by a very equitable climate, and becomes a *coal age*. In time, the pressure of accumulating sediments squeezes out molten rock to the surface, and we have a major *volcanic period*, such as covered the Deccan 600,000 square miles with lava 1000 feet thick, and Southern Australia from Mount Gambier in South Australia to Melbourne and North-East Tasmania with basaltic lava in places hundreds of feet in thickness. This is accompanied by a period of great mountain foldings. These two results release the accumulated pressures and internal heat, and are followed by an *ice age*. Then the world settles down to a long period of quiescence—30 million years or so—until erosion again upsets the balance. The forms of life develop slowly during the quiescent period, primarily under the influence of normal biological controls, but each revolution marks a change in environment, which is always accompanied by the extermination of many forms, the rise of some newer and more highly developed forms, and a regrouping of life generally. The ancestral forms of each phylum have probably been in existence since Pre-Cambrian times, but each revolution gives an impetus to some previously repressed form, and spurs on development to an extent not seen with any other influence.

There have been, in all, some 20 revolutions of varying intensity, of which some four or six were of outstanding intensity. These are usually known as: (1) The Charian, which initiated the Cambrian period; (2) the Caledonian, which terminated the Silurian and initiated the Devonian; (3) the Hercynian, which terminated the Permian period—the end of the Palaeozoic era—and initiated the Mesozoic era; and (4) the Alpine, which commenced in the early Tertiary, and which is only just terminating. It is impossible here to describe the effects of these revolutions, and I must be content to remark that each produced very definite land masses and mountain ranges, traced in many parts of the world, and which were reflected in Tasmania.

We may therefore truly describe the world as pulsating. History shows a definite rhythm, and this rhythm is part of the very nature of the earth. Moreover, it has supplied the motif for the development of all land features and all forms of plant and animal life. Indeed, it is not too much to say that life itself is but one manifestation of this pulsating, rhythmic attribute of the earth—the mother of all life.

Man

And so, finally, we come to MAN. It is out of the question for me to discuss here the origin of the genus of *Homo*, but we can see the results of the world's pulsations nowhere better than in the story of the human race. When the early ancestors of the primates were hunting across the Eurasian plains with their shaggy coats and long tails, there were no Alps or Himalayas, no Mediterranean, no Bass Strait. The Tertiary period has witnessed the development of our present geography. The preceding era had been the age of the giant reptiles. With the beginnings of the Tertiary we see the rise to prominence of the insects and their associates—the flowering plants and grasses. At first, plant and animal forms spread indiscriminately through the world—eucalyptus trees and marsupials in Europe and America, oaks, elms, willows, &c., in Australia. At this time land was emerging from the great sea, Thetys. Ancient Malaya connected Southern India with Australia, Central Australia and the Ganges valley were under the ocean, and Tasmania was connected to South America *via* the Antarctic. Then followed a great outpouring of volcanic lava over a considerable portion of the earth's surface. The Alpine-Himalayan chain was gradually folded over the remnants of the Hercynian mountains, and the Pacific squeezed its margins outwards over America, Asia, and Australia. Finally, the world passed into the last ice age—from which we are now only just emerging.

The world is divided into certain geographical zones, as shown in Fig. 4. Man originated in the equatorial forest belt (from North Africa to Malaya), before the Alpine-Himalayan chain had been raised sufficiently to form an impassable barrier, and here the forbears of our race lived for perhaps 10 million years, until the pulsations of the globe which gave them birth shook them from their leisured existence. The gradually rising mountain barriers very early segregated branches of the human family, and, probably, from originally black-skinned ancestors the more progressive races developed from stocks trapped north of the mountains. Then the ice age came on. This had a very marked bearing on the distribution of these geographical zones. Segregation into such zones does not appear to be usual in earth history, but is a definite accompaniment of an ice age, and the polar ice sheets control the distribution of each zone. As the ice advances from the poles each zone presses nearer the equator and contracts the equatorial forest belt, and as the ice retreats the other zones follow it towards the poles, allowing the equatorial forest belt to expand. There were four separate ice invasions during the last ice age. Four times the ice has advanced and receded. On each occasion it reached to about the latitude of southern England, central Germany, and Russia, and the Canadian-U.S.A. border.

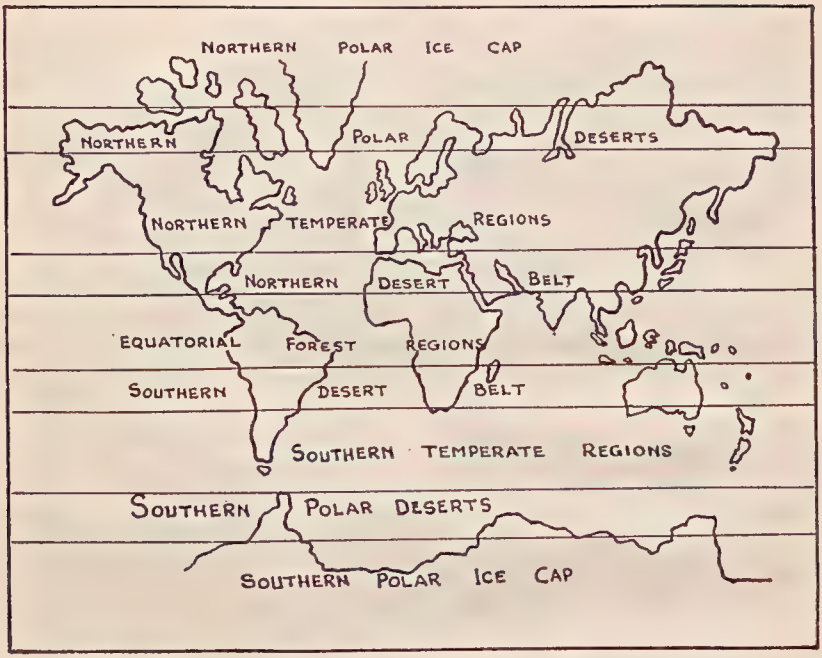

Fig. 4.—The Major Geographical Zones of the Surface of the World.

Prior to the first onset, man's ancestors had spread widely through the tropical forests. It took a large area to support a small number of these primitive tribes. Apes and monkeys were well developed, and also *Pithecantropus* and his contemporaries. Then the ice came down and pushed the desert belt southward, contracting the forests, and, with them, man's food areas. In time, the ice receded, but the consequence of the intense struggle for existence caused by this restriction was a new race of mankind—higher in every way. This happened three times more, until the modern races grew from the intense struggles of nature's testing—aided in some cases by climate and by the fact that some races were trapped between mountains and deserts to the south and the cold temperature regions to the north. These influences also directed and controlled migrations until the greater portion of the world was populated. In places, earth movements and long extensions of the oceans along newly forming troughs cut off and protected remnants of earlier races. In other parts the struggle for existence, nature's uplifting influence, continued, for some fortunate groups, the work initiated by ice.

Another and very important factor also resulted from the ice age. As a great deal of water was stored up as ice, the level of the sea sank. This occurred to a depth of 150 feet all over the

world at the time of maximum intensity. During that time rivers and streams were enabled to cut below present sea-level, and coral reefs could grow at a depth at which coral cannot live to-day. As the ice melted the sea level arose and dammed back the newly cut valleys. During the interglacial phases the sea level actually rose higher than we see it to-day, as we are not yet entirely out of the last, or fourth, glacial phase. This caused the streams to deposit terraces in their newly eroded valleys. During later ice phases these terraces were largely eroded again. So we can see to-day over much of the world, including Tasmania, a definite series of three or four terraces at the mouths of rivers. Now, primitive races of mankind lived along the courses of these rivers, and left their bones and their tools in the river mud and gravel. The anatomist can trace the development of the races in the bone remains, and the association of stone implements with these bones enables us to classify human culture in historical sequence. The geographical sequence of the terraces is easy to work out, and in this way human history has been correlated with the earth pulsations which both produced the terraces and induced the development of successive races. To this scale has been added another. In regions on the border of an ice cap, in winter time, the water is frozen and stationary. Summer melts much ice, and the water carries away a great quantity of material worn by the ice from its bed. This is deposited as a fairly thick layer. The succeeding winter makes a break, when only a very thin layer or none at all is deposited. Thus is built up a rock known as *varved shales*, in which the record of passing years is accurately preserved. These alternating seasonal layers have been counted in many places, and an absolutely correct time scale is thus provided.

The story of the human race has been laboriously built up from all those various factors, and we can now place the origin of different peoples in their correct relationship relatively to each other. We can connect human occupation of a given locality with the river terrace in the process of formation at the time of that occupation, and we can correlate these terraces by means of the known phases of the ice invasions, with corresponding terraces anywhere in the world. The combined result gives us an accurate history of man's occupancy of the earth and an accurate geography of any given locality at any particular stage of the human period. (See for Tasmania the diagrams given in my paper published in this journal for 1934. The succession there given corresponds very closely with that in England.)

Earth Movements in Tasmania

Tasmania occupies a very important and definite position in geography as a wedge of the Australian continental mass projecting into the oceanic masses to the east and west. These masses have

been in approximately the same relative position since the beginning of geological time, and Tasmania has been, as it were, a buffer. Thus, it has been subjected to continued stresses—at one time of compression, at another of torsion—with a result that it has never been stable, and, whereas on the mainland it is possible to go from Broken Hill to Broome—nearly 3000 miles—without a major change of rock, Tasmania has representatives of almost every geological period and has felt the effects of every earth movement. (Fig. 5.)

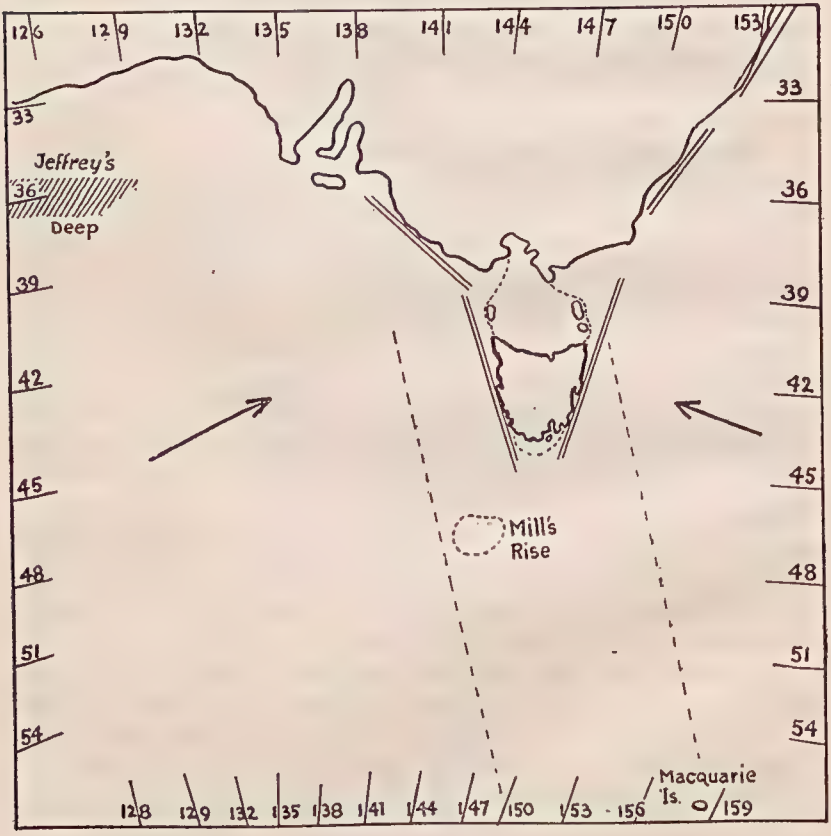

Fig. 5.—The Major Continental Trend Lines in the Neighbourhood of the Tasmanian Peninsula.

Tasmania is the southern terminal of the Eastern Australian Continent. Bass Strait is merely a flooded portion of this peninsula. The diagram illustrates the position of Tasmania as a wedge between two converging pressures. The submarine ridge of which Mill's Rise and Macquarie Island are portions has not yet been satisfactorily explained, but is clearly associated with the general structure of the Eastern Australian Continent.

We have only time to deal with the most recent. A revolution which closed the Silurian, and which may be roughly correlated with the Caledonian of Europe, left a cordillera of mountains over the present position of Tasmania, folded over older land to the west and enclosing great batholiths of granite. This would be

Fig. 6.—The Two Granite Arcs.

These form the skeleton of Tasmanian physiographic structure. The actual centre of the axis of subsidence during Permian times may have been further north, under the now flooded Bass Strait, but the position shown on the diagram is the apparent axis as far as data at present available indicate. Granite outcrops are shaded. Many facts indicate considerable subterranean masses within the dotted lines indicating each arc.

some 420 million years ago. Before Carboniferous times these mountains had been eroded to a plain, exposing the granite cores. One hundred and sixty million years are represented in this phase. Then followed a general and very slow subsidence to the southward about an axis roughly across Northern Tasmania. (Fig. 6.) In

the trough thus formed, which was probably only the northern extension of a greater block extending perhaps to Antarctica, sediments typical of shallow seas, sand dunes, and swamps, accumulated to a depth of perhaps 8000 feet. This phase extended until the Triassic or Jurassic periods, some 60 million years. Then the geosyncline thus formed foundered in an upwelling magma of basaltic *Sima*, which intruded on the sediments, and gave us our dolerite rocks. These sequences are also to be found on the coast of Antarctica opposite Tasmania, indicating that Tasmania and Adelie Land were the edges of a vast foundering land mass. The doleritic intrusions may be roughly correlated with the Hercynian revolution of Europe, but somewhat later in point of time.

We can form little idea of the geography of Tasmania at this time, but it was very broken, with perhaps mountain ranges. A long interval of quiescence followed—some 100 million years—during which the land was worn to a level plain. Then Tasmania felt the effects of the earth revolution which also produced the Alpine-Himalayan and Rocky-Andean mountain chains. At this time, and very likely at other earlier times, Tasmania extended far to the east and west of its present coasts, and was part of an inland continental mass. The Alpine revolution was not felt as severely as in Europe or New Zealand, but more so than in Australia. As a result of pressure from east and west, Tasmania was broken and uplifted in jagged blocks, and at the same time there were large subsidences off the coasts. The first of the uplifts raised the western area and the north-east corner, and sufficient time elapsed to erode the overlying sediments and dolerite sills from these parts. This uplift must have been in the vicinity of 8000 feet, and was most pronounced. Then came a fairly general uplift over all Southern and Eastern Tasmania, excluding the north coast and the midlands. The extent of this was about 1500 feet. Subsequently disjointed blocks were raised to a further 3000 feet, and now appear as our mountains. There were several such movements, and blocks were raised differentially. Accompanying these uplifts, considerable subsidence off the west and the north-east coasts occurred, and, later, a large area off the southern coast of Tasmania, including Storm Bay, foundered along very regular breaks. This, in its turn, had a marked effect on the valley erosion in the south, rejuvenating the rivers and giving a marked trough in the old valleys. The original sides of the pre-submergence valleys can be plainly seen on the platform at 500-400 feet along the Derwent Valley and hills of Southern Tasmania.

These movements extended into the ice age. We can follow the four ice ages in Tasmania, although the first is obscure. These provide an excellent correlating time-scale, particularly as the latest elevation occurred subsequently to the two earlier ice phases. It is apparent that very dry conditions prevailed in Tasmania during some of the interglacial phases, and during the ice phases many

rivers in the unaffected coastal portions were much more considerable than at the present time. River terraces all along our coasts correspond very closely with similar features in Europe.

During each ice age the streams cut below present sea-level, and during each interglacial phase the sea-level rose and banked back the streams so that they deposited terraces in the valleys previously excavated. These terraces can be correlated with the various ice ages. So can the movements of the desert belts. Therefore, when the remains left by a particular human race are found in or on a particular terrace you can say that they appeared in that locality at a given time. These successive factors have been worked out for the Thames valley, and now research shows that a corresponding time-scale is available for Tasmania. The Derwent, Coal, Huon, and Tamar valleys show series of terraces that correspond remarkably accurately with those of Europe. The Derwent and other rivers have cut 150 feet below present sea level, and have piled up terraces to an elevation of 100 feet above sea level (Lewis, 1935). These over-deepenings and terraces correspond to the rise and fall of the sea level during the ice age. During these rises and fallings, so accurately marked by river cuttings and terrace buildings, and, in higher altitudes, by the effect of ice, man arrived in Tasmania. The date can be accurately fixed as during the Yolande-Margaret interglacial, as his artifacts appear suddenly on these terraces. That corresponds to the Riss-Würm, interglacial of the northern hemisphere, and may be dated as 150,000 years ago.

A considerable controversy has arisen lately as to how the Tasmanian aborigines arrived here. Until the last year or so, Sir Edgeworth David's dictum that they arrived across a dry Bassian land bridge was accepted. Professor David showed that the maximum phase of the Mindel (Malanna) glaciation the sea was 150 feet lower than it is to-day. That this was so is demonstrated by the Derwent trough. This would have been sufficient to have given a double land bridge across Bass Strait. Unfortunately for this convenient theory, recent work shows that the aborigines did not arrive until much later. During Mindel times—some 600,000 years ago—the Negrito race, of which the Tasmanians were a branch, were developing in Northern India, and had not spread further. They did not reach Southern Australia until much later. The subsequent ice ages were not sufficiently intense to lower the sea level to a depth which would make a land connexion between Tasmania and Victoria. Investigation of the coast of Bass Strait indicates that the coast-line, at any rate, has not sunk in post-Yolande times.

Why did the aborigines cross to Tasmania? The answer is clear. Throughout the period from their first migration into Australia, the central desert belt, in response to the pull of the ice-sheet, was

moving up and down across the continent. At the time they first appeared in Tasmania the southern portion of Australia was in the grip of the desert. To such an extent was this so that the Buffalo ranges in Victoria at 5000 feet show no signs of permanent snow, while ice descended to sea level on the west coast of Tasmania only 400 miles further south.

Fig. 7.—The Bassian Trough.

The diagram illustrates the general trend lines of the geography of Bass Strait. It also illustrates the vital connexion between geographical data to be gathered on both sides of the strait. The neglect of this correlation has led to many of the doubts which now exist as to the geography of South-eastern Australia.

An examination of Bass Strait is instructive. Although the Tasmanian coast shows terraces dating back to at least Yolande times, soundings disclose a peculiar trough 270 feet below sea level. This is a lenticular extension of the plains that run from Tunbridge to the coast in Tasmania, and from Bacchus Marsh to Port

Phillip in Victoria, and it connects these plains. The Bassian trough cannot be waterworn, and as there is no outlet, if it had not been flooded, it would have been an inland sea or salt lake. It can only be due to earth movements. The subsidence south of Tasmania is of very recent date, so much so that at least two river valleys flowing from the ocean northwards are observable—one at Port Davey and one at Cockle Creek. The Flinders and Otway troughs and the subsidence to the south indicate a squeezing movement, and point to the origin of this submerged inland sea. When did all this happen? The very shape and nature of the Bassian trough point to a possible counterpart—the Dead Sea and Jordan Valley.

Palestine as a Key to Tasmanian Physiography

Palestine presents a remarkable key to some of the problems of more recent Tasmanian physiography. The plateaux of Judea and Moab were uplifted at approximately the same time as our Central Plateau, and to the same height. The earth movements that produced both sets of features were due to the same agency, and were exactly similar in origin and effect, and the boundary fractures as described for Palestine might be the faults which are causing us so many difficulties in interpretation here. Pictures of the Judean Mountains from the Philistine Plain, and of the Western Tiers from the South Esk Valley, illustrate the similarity better than any words can do. But beyond these features, there are two others: (1) The flooded area of the Mediterranean, and (2) the rift valley of Dead Sea. From Galilee to Akaba there extends a break in the plateau which, at one place, drops to 600 feet below the sea level. This is an area which has played the most important part in the history of mankind, and there has been preserved for us an actual historical record of happenings here during the life of human beings. We now have brought our story of the world down to the time of the Book of Genesis. Two early legends are there preserved from a time far more ancient than the time when they were reduced to writing. The first is the story of the Flood, and the second is the story of Lot.

The Flood was an actual happening, established beyond doubt by the wide distribution of legends through the earliest writings of mankind. It was presumed, until recently, that it was the result of the rising of the sea level after the last (Würm or Margaret) ice phase. It could not have been this, as the rise was insignificant. The rise after the Mindel ice sheet had waned would have been sufficient, but at that time—600,000 years ago—the human race was too primitive to make records. The evidence all points to the fact that

the Flood was the result of the submergence of the Mediterranean-Euxine-Caspian-Aral basin, as the last phase of the earth movements associated with the Alpine revolution. The land then submerged was the happy hunting ground of the Iberian peoples, sometimes known as the Dark Whites, represented in history by the Iberians of Spain, the Trojans, the Philistines with their great cities Tyre and Carthage, the Helots of Greece, and some of the tribes of Italy. These people were 'wicked' (that is, foreigners) to the writers of the Old Testament. To them the Flood was the outstanding event in history and the source of many legends. At about the same time, and as the result of similar earth movements, the transverse fissure of the Jordan valley subsided and we read the account, written at a much later date, of this happening in the story of Lot. The Cities of the Plain are traditionallly situated in the Dead Sea basin, and Genesis specifically mentions Lot as escaping to Moab, an unlikely course if these cities had been situate in the Philistine Plain. No other localities fit. Genesis states that Sodom and Gomorrah were overwhelmed with fire and brimstone. No volcanic activity appears to have occurred in these regions, but earthquake movements were highly probable, and considerable landslides from the 4000-foot cliffs surrounding the rift valley were also possible. The date of these happenings may be fixed at late Azilian times—about 40,000 B.C.—and they are confirmed by ethnological, geological, and geographical evidence.

Some such minor earth adjustment is apparent across Bass Strait and to the south of Tasmania, and the similarity is too close to be ignored, although, getting so close to the present day, actual contemporaneity to a few thousand years cannot be pressed in the present state of our knowledge. Nevertheless this fact is undoubted. We see certain results of earth movements in Tasmania, and portion of the human race has left some legendary records of very similar happenings elsewhere. In the absence of reasonable text-books of Tasmanian geography we must turn to the legends of Genesis for assistance.

In the present imperfect state of our knowledge I am not prepared to say that Bass Strait was submerged after the coming of the Tasmanian aborigines. The evidence of the coastal terraces points in the other direction, but Bass Strait is an earthquake zone at the present time, and the great trough was probably the result of a continual pressure or subsidence after the formation of the terraces and the passage of the aborigines. This, however, does not affect the general similarity of the earth movements.

I give below a list of works which should be consulted by students who are interested in the subject of this lecture. The list is arranged in the order recommended for study.

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1. Holmes, Arthur.—*The Age of the Earth.* (Benn's Sixpenny Library.)
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3. Lewis, A. N., 1935.—Correlation of the Tasmanian Pleistocene Raised Beaches and River Terraces in Unglaciated Areas. *Pap. Roy. Soc. Tasm.* 1934, p. 75 (1935).
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The Trout-Food Insects of Tasmania

Part II.—A Monograph of the Mayflies of Tasmania

By

R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.R.S., F.R.S.N.Z., F.R.E.S., &c.

Plate I

In Part I of this series of studies, (1934) I dealt with the problem of the genotype of the Mayfly genus *Atalophlebia* Eaton. Now that this problem is satisfactorily solved, and the characters of the genus firmly established, it is possible to make a survey of the whole Mayfly fauna of Tasmania. The interesting fact at once emerges that about two-thirds of this fauna consist of species of *Atalophlebia*, and that most of the species have a very close relationship with forms which occur on the highlands of Victoria and southern New South Wales. But in these parts of continental Australia the Mayfly fauna is far more varied than it is in Tasmania. In the family Siphlonuridae, there is only a single species of *Tasmanophlebia* recorded from Tasmania, whereas from the Mount Kosciusko region alone (Tillyard, 1933) there are known, in this family, two species of *Tasmanophlebia*, one of *Ameletoides*, and two of *Coloburiscus*.

Of these, it is noteworthy that *Tasmanophlebia* possesses nymphs which live in still, or nearly still, water, whereas those of the other two genera require running water. In the family Leptophlebiidae again, the most striking development of species in Tasmania is a group of closely-related species of large size in which the structure of the gills appears to indicate that they have all been originally derived from one or two forms whose nymphs inhabited still or

slowly-running water. In the Mount Kosciusko region, on the other hand, the principal development of this same genus consists of a complex of forms whose nymphs live in fast-running water, and there is also present a related genus, as yet undescribed, whose larva burrows into the sandy beds of running streams.

Thus, in studying the Mayfly fauna of Tasmania, we are faced at once with the same problem as in the case of the Dragonflies: although the island is plentifully supplied with fast-running rivers, the aquatic fauna present appears to have been derived from a stock living in still or slowly-moving water. As I have pointed out previously, in my study of the Dragonflies in relation to the Bassian Isthmus [i.e., the original land-connexion between Tasmania and the mainland (Tillyard, 1914)], no less than 78·9 per cent. of the still-water species of Odonata are common to Tasmania and Victoria out of the species found in both States; whereas, in the case of the running-water forms, only 22·7 per cent. are common to both, and, of these, one is a species which occasionally breeds in still water, and the other two breed in slowly-running water.

The inevitable conclusion must be that, during the geological periods in which most of the Tasmanian Dragonfly and Mayfly fauna reached the island, the land-connexion with Australia proper was only a narrow, or possibly even a discontinuous, one, with sufficient still waters to allow of the free migration of forms inhabiting them, but with so little development of permanently-running streams that very few of the forms inhabiting such streams were able to get across. Further, it is clear that the great majority of species reached Tasmania from the north, and not from the south, though there is one important exception, viz., the rare Dragonfly *Archipetalia auriculata* Till. from the Cradle Mountain region, which had not been discovered when my 1914 paper was written.

Although, no doubt, further collecting, particularly in the western half of Tasmania, will bring to light a few more species, we know enough about the Tasmanian Mayflies to be able to give a fairly full account of them. It appears, for instance, highly improbable that the Siphlonurid genus *Coloburiscus* occurs at all on the island, although it is common in all fast-running streams throughout New Zealand and on the highlands of Eastern Australia. This genus is taken as the 'indicator' for good trout-streams in New Zealand; for wherever its larva occurs, the water is found to be of first-class quality for trout and of exceptional purity. It is certain that, if any species of this genus had succeeded in getting into Tasmania, it would have spread rapidly through all the fast-running rivers, and would have made an excellent food for trout. But so far it has not been found, though the larvae are conspicuous objects of comparatively large size.

In the present paper the following Mayfly fauna is dealt with:—

Family SIPHLONURIDAE....	1. *Tasmanophlebia lacustris* Till.
Family LEPTOPHLEBIIDAE	2. *Atalophlebia australis* (Walk.)
	3. *Atalophlebia superba*, sp. nov.
	4. *Atalophlebia hudsoni*, sp. nov.
	5. *Atalophlebia albiterminata*, sp.
	6. *Atalophlebia ida*, sp. nov.
	7. *Atalophlebia fuscula*, sp. nov.
	8. *Atalophlebia brunnea*, sp. nov.
	9. *Atalophlebia delicatula*, sp. nov.
Family BAËTIDAE....	10. *Baëtis frater*, sp. nov.
	11. *Cloëon tasmaniae*, sp. nov.
Family CAENIDAE	12. *Tasmanocoenis tonnoiri* Lestage
	13. *Caenis scotti*, sp. nov.

KEY TO FAMILIES

1. Hindwings comparatively large, about half as long as the fore	Fam. *Siphlonuridae*
Hindwings small or entirely absent	2
2. Forewings with a plentiful supply of cross-veins, giving a reticulate appearance; hindwings small, but also reticulated	Fam. *Leptophlebiidae*
Forewings with few cross-veins and a generally open appearance	3
3. Males with turban-eyes (Text-figs. 24, 25); marginal short veins (intercalary veins) developed between the ends of the main veins	Fam. *Baëtidae*
Males with small, button-like eyes placed wide apart; no marginal short veins developed between the ends of the main veins	Fam. *Caenidae*

In defining the families and genera more fully, recourse must be had to the venational scheme, where the main differences relied upon for classification are to be found. Reference should therefore be made to the text-figures of the wings of the various genera, in which the Comstock-Needham terminology is used, as amended by myself for this particular order. Students should note, in particular, that there is, in the Mayfly wing, a complete alternation of convex and concave veins; this is indicated in the legend of text-fig. 1. It is usual to indicate convex veins by the sign +, and concave veins by the sign —.

To Lameere is due the recognition that the media in Mayfly wings is a composite vein, consisting of *anterior (convex) media*, MA, and *posterior (concave) media*, MP. In all existing Mayflies, MA is attached basally to the radial sector, Rs. In order to bring the notation of the cubitus as far as possible into line with that of the media, the *anterior (convex) cubitus* is here designated CuA, instead of the usual Cu_1, and the posterior (concave) cubitus CuP, instead of

the usual Cu_2. This course also enables us to avoid awkward suffixes for the branches of CuA. It should also be noted that the main stem of the radius is really the anterior convex portion of that vein, and might with advantage be termed RA, while the 'radial sector,' universally known as Rs, is in reality the posterior concave portion, and might be more logically termed RP.

Mayfly venation (text-fig. 1) differs essentially from that of any other order of insects, not only in the complete alternation of convex and concave veins, but also in the formation of *triads*. When a main vein branches distally into two, the alternation of convex and concave veins is kept intact by the development, between these two

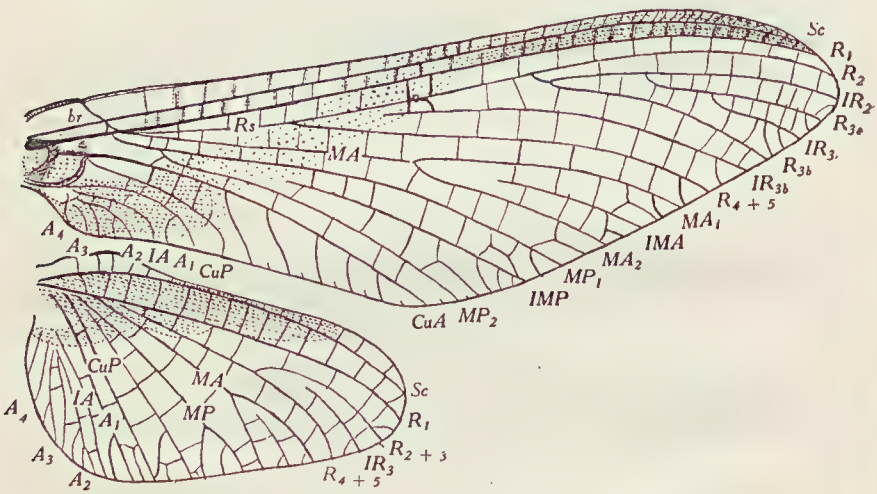


Fig. 1.—Venation of *Tasmanophlebia lacustris* Till. Male imago, from Great Lake, Tasmania.

A_1, A_2, A_3, anal veins (convex); *br* bridge vein; C, costa (convex); CuA, anterior cubitus (convex); CuP, posterior cubitus (concave); MA, anterior media (convex); MP, posterior media (concave); *pt*, pterostigma; R_1, radius (convex); R_2, R_3, R_4, R_5, branches of the radial sector, Rs, all concave; Sc, subcosta (concave); interpolated veins (middle members of triads) are distinguished by the prefix "I."

branches, of an extra, interpolated vein of opposite sign between the two branches. These middle veins of triads are distinguished by the addition of the prefix 'I'; e.g., the triad of MA consists of MA_1 (+) IMA (−), and MA_2 (+). Triads are normally developed on the branches of Rs, Ma, and MP only, i.e., on those branches which proceed to the distal or outer margin of the wing, from apex to tornus. As it is doubtful how far the formation of the distal part of CuA in the Leptophlebiidae is a true triad, it is left unlabelled in this paper. In the older family Siphlonuridae there is no triad on CuA, but a pectinate series of descending veinlets. A short interpolated anal vein, IA, can also be recognized in this family.

Family SIPHLONURIDAE

Genus **Tasmanophlebia** Tillyard, 1921

This genus, the only known Tasmanian representative of the family, can be at once recognized by the large size of the hindwings, which are about half as long as the fore and almost as wide, with the humeral angle well developed and obtuse. In the forewing the triad of MA is distally placed, that of MP very long, arising basally, and not attached to CuA. In correlation with the size of the hindwing, the tornus or posterior angle of the forewing is placed about half-way between base and apex, giving the wing the general shape of an obtuse-angled triangle.

In both sexes, except in the forelegs of the male, the tarsi are apparently only four-segmented, owing to the basal segment being more or less fused with the tibia; the forelegs of the male are greatly elongated. The tarsal claws are in all cases dissimilar, one being sharply hooked and one broad and blunt, with rounded apex. The abdomen is narrowly cylindrical, without any lateral dilations.

The *larva* or *nymph* is free-swimming, dorso-ventrally flattened, the thorax not humped; the abdominal segments have a median dorsal crest and lateral flanges with strongly projecting posterior angles. There are only four pairs of simple gills, carried dorsally upon the abdomen, one pair on each of segments 1-4; of these, the first pair are strongly chitinized lamellae forming gill-covers or opercula for the rest, which fit closely under them.

The genus is the Australian and Tasmanian representative of the well-known New Zealand genus *Oniscigaster* McLach. It differs from the latter in not possessing lateral flanges to any of the abdominal segments in the adult, and in the specialization and reduction of the nymphal gills.

Genotype.—Tasmanophlebia lacustris Till.

Habitat.—Lakes and still reaches of mountain streams in Tasmania and the uplands of South-Eastern Australia.

1. Tasmanophlebia lacustris Till.

(Plate I, figs. 1, 2; text-figs. 1, 2, 3)

Tillyard, 1921, *Proc. Linn. Soc. N.S.W.*, xlvi., pp. 409-412, pl. xxxiv.

This species was originally described from Lake Lilla, Cradle Mountain, North-Western Tasmania. It is now known to occur also in the Great Lake, Lakes Echo and St. Clair, and more commonly in the Penstock and Shannon Lagoons, not far from the Great Lake.

The type series, consisting of one imago of each sex and also one subimago of each sex, is now seen to be somewhat below the average size of the species; the average expanse is about an inch, the males

being slightly smaller than the females, and much less numerous. Some additions to the original description may suitably be made here, as follows:—

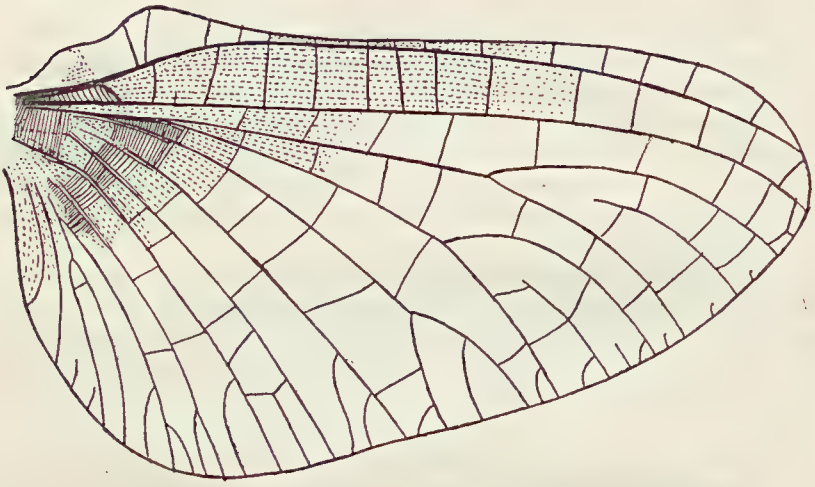


Fig. 2.—*Tasmanophlebia lacustris* Till. Hindwing. Length 5·5 mm.

In the IMAGO, the male can be at once distinguished from the female by a rich brown longitudinal mark on the forewing (Plate I, figs. 1, 2), extending outwards from the base posteriorly to CuP. There is a similar but longer mark, about 3 mm. long, covering the basal sixth of the hindwing and also extending outwards along the subcostal space to about two-thirds (text-fig. 2). Further, the brown markings along the costa of the forewing are much stronger in the male, particularly in the region of the pterostigma.

The *hindwing* (text-fig. 2) differs from those of the mainland species in having the humeral projection of the costal margin irregular and rounded at its apex instead of being a simple obtuse angle. The definition of the genus therefore needs to be amended, and should properly read 'hindwing with humeral angle prominent, either obtuse-angled or irregularly humped and rounded.'

In the SUBIMAGO, the general colour of the wings in both sexes is a medium fuscous, with a slightly paler lunule passing from about the middle of the costa of the forewing to the tornus; the part of the wing situated basally from the lunule is slightly paler than the distal part; in the hindwing, the wing is darkest around the distal portion.

The NYMPH (text-fig. 3), previously unknown, may be described as follows:—Total length of body (average) 16 mm., tail filaments 6 mm. *Head* narrow, eyes wide apart in female but touching in male; antennae short, subulicorn. Thorax fairly stout; the legs short, rather slender, tibio-tarsus divided obliquely and end-

ing in a single claw. *Abdomen* with short, backwardly projecting dorsal spines only on segs. 1-5; lateral spines present on segs. 1-9. Gill-covers or opercula large, extending to the end of seg. 5, slightly irregular in shape, the inner margin subangulate not far from base, but otherwise oval in form. Caudal filaments short, strongly fringed, the middle one on both sides, the outer ones on the inner margin only. General coloration sandy, with mottled brownish markings; eyes and wing-sheaths dark, tail filaments with darker annulations.

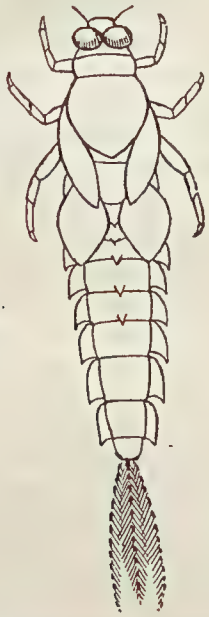


Fig. 3.—*Tasmanophlebia lacustris* Till. Full-grown nymph (male). Length, excluding tail-filaments, 16 mm.

In general appearance, this nymph comes close to that of *T. nigrescens* Till. from Mount Kosciusko (Tillyard, 1934, p. 19); it also agrees with it in having the dorsal spines confined to segs. 1-5; these, however, are much smaller and less nodding than in *T. nigrescens*, that of seg. 1 particularly being small.

Types.—Holotype male imago, allotype female imago, type male and female subimagos, from Lake Lilla, Cradle Mountain, North-Western Tasmania (R. J. Tillyard, 21st January, 1917); type nymph (male) and series of paratypes (in spirit), from Todd's Corner, Great Lake (R. J. Tillyard, 28th January, 1933).

Family LEPTOPHLEBIIDAE

In this family the hindwings are small, from less than 1 mm. to about 3 mm. in length, but always more or less reticulated. The

forewings have a complete system of cross-veins, though the series of costal veinlets may be incomplete in some of the smaller species. The nymphs are of the crawling type, and may be found under stones, rocks, logs, &c., in either still or running water. Their tail-filaments are long and filiform, not fringed as in the Siphlonuridae and Baëtidae, but only very lightly hairy.

All the Tasmanian species so far discovered belong to the genus *Atalophlebia*, which has its headquarters in Australia and New Zealand. In New Zealand the larger species of the family Leptophlebiidae belong to the genus *Atalophlebia*, the smaller to the genus *Deleatidium*; the only valid difference between them appears to be that the nymphs of the former have double gills, while those of the latter have single gills. I have shown that the supposed difference in the tarsal claws of the adult does not hold (Tillyard, 1934, pp. 4, 7), as the genotype, *A. australis* (Walk.), has the claws similar in shape, each provided with a transparent flange. All the Tasmanian species of which the nymphs are known possess double gills, and must therefore be placed in *Atalophlebia*. The nymphs also all possess denticulate tarsal claws, thus distinguishing them from the nymphs of the South African genus *Aprionyx* Barnard, which is otherwise closely allied to *Atalophlebia*.

The most striking character of the genus *Atalophlebia* is the form of the hindwing (text-figs. 4-9), in which the costal border is always peculiarly humped, the costal space becoming narrowed beyond the hump, and the subcostal space being very broad.

Having previously defined the genus very fully (Tillyard, 1934), and having also given a full description of the genotype, *A. australis* (Walk.), it now only remains to describe the other known Tasmanian species, and to give keys for the separation of the imagos, subimagos, and nymphs, as far as these are known. In order to shorten the descriptions as far as possible, reference will be made to those parts of *A. australis* which have already been fully described and figured in such cases as the corresponding parts of other species only differ slightly from those of the genotype.

It should be noted that the Tasmanian species of *Atalophlebia* can be arranged in two quite distinct groups, one consisting of comparatively large species in which the nymphal gills are digitate, and the other consisting of much smaller species in which the gills are narrowly lanceolate. This distinction will be made use of in the keys.

Keys to the Tasmanian Species of the Genus Atalophlebia

I. Imagos

1. Larger species, expanding about an inch (forewing from 10 to 13 mm. long) 2
   Smaller species, expanding from one-half to three-quarters of an inch (forewing from 5 to 8 mm. long) 6

2. Forewings with two large black spots (each 1 to 1·5 mm. in diameter) near middle, one on costa and one below it, also many smaller spots along and below costa .... *A. ida*, sp. nov.
Forewings not spotted 3

3. Forewings with black venation and costal veinlets widely darkened; body black; males with two extremely long tail-filaments, black tipped with white .... *A. albiterminata*, sp. nov.
Colour of wings and body brown, orange, or red 4

4. Abdomen distinctly red; tail-filaments usually three, rarely two .... *A. australis* (Walk.)
Abdomen brown or orange-brown; tail-filaments two only, stout 5

5. Thorax brown with a mid-longitudinal dorsal orange stripe; abdomen fulvous .... *A. hudsoni*, sp. nov.
Thorax dark brown without any orange stripe; abdomen brown .... *A. superba*, sp. nov.

6. General colour a medium brown; wings with brown veins .... *A. brunnea*, sp. nov.
General colour grey or fuscous 7

7. Forewing about 7 mm., rather broad, veins black; general body colouring dark fuscous, the whole insect appearing blackish in life when at rest .... *A. fuscula*, sp. nov.
Forewing about 5 mm., long and narrow, veins thin, fuscous; general body colouring medium fuscous .... *A. inconspicua* Eat.

II. Subimagos

1. Larger species, expanding about an inch (forewing from 10 to 13 mm. long) 2
Smaller species, expanding from one-half to three-quarters of an inch (forewing from 5 to 8 mm. long) 5

2. Forewings pale greyish, marked with two large dark spots near middle and numerous smaller spots along and below costa .... *A. ida*, sp. nov.
Forewings dark, with paler areas 3

3. Lambda-mark complete or almost complete (Plate I, fig. 3) very clearly visible in living insect when at rest; abdomen reddish .... *A. australis* (Walk.)
Lambda-mark incomplete, broken up into three or four fragments; abdomen brown or black 4

4. General colour a rich dark brown .... *A. superba*, sp. nov.
General colour black .... *A. albiterminata*, sp. nov.

5. Forewings pale brownish, slightly mottled .... *A. brunnea*, sp. nov.
Forewings grey or fuscous 6

6. Forewing about 7 mm., dark fuscous, appearing almost black in the living insect at rest .... *A. fuscula*, sp. nov.
Forewing about 5 mm., much narrower than above, pale greyish, slightly mottled .... *A. inconspicua* Eat.

Note.—The subimago of *A. hudsoni* sp. nov. is not known.

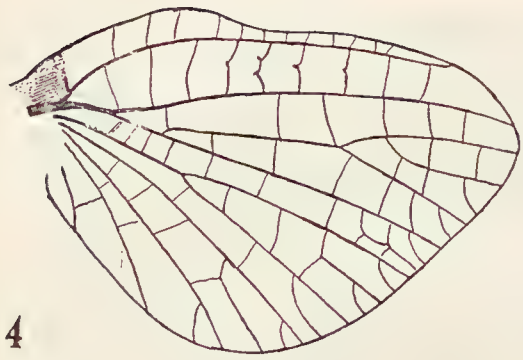
III. Nymphs

1. Large nymphs, length of body when full-grown 12 to 16 mm.; gills digitate (Text-figs. 17, 18) 2
Smaller nymph, length of body 7 to 8 mm. when full-grown; gills entire, lanceolate (Text-fig. 19) .... *A. fuscula*, sp. nov.

8. General colour very dark brown to blackish; gills wide, multidigitate (Text-fig. 18); three tail-filaments .... *A. albiterminata*, sp. nov.
General colour rich brown or reddish-brown 3

3. General colour reddish-brown; tail-filaments three, approximately equal .... *A. australis* (Walk.)
General colour rich chocolate-brown; two very stout cerci and a slender, very short appendix dorsalis .... *A. superba*, sp. nov.

Note.—Of the three smaller species *A. fuscula*, sp. nov., *A. brunnea*, sp. nov., and *A. inconspicua* Eat., only the nymph of *A. fuscula*, sp. nov., has been determined.



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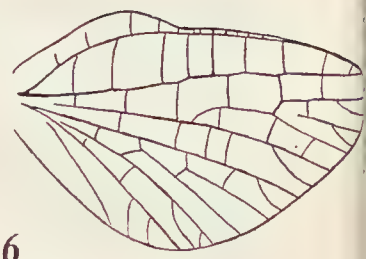

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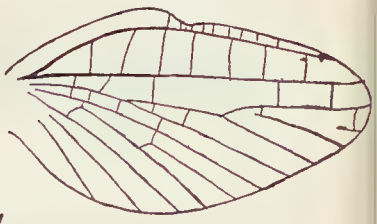

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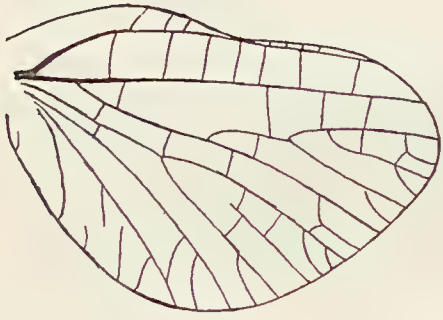

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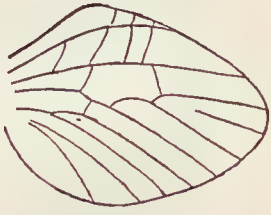

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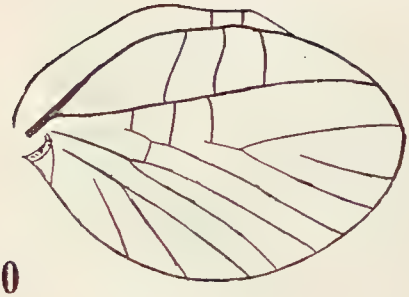

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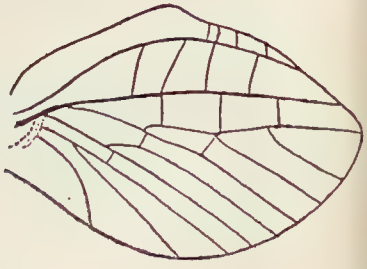

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Figs. 4-10.—Hindwings of the genus *Atalophlebia:*

4. *A. superba* n. sp. (length 4 mm.).
5. *A. hudsoni* n. sp. (length 3·5 mm.).
6. *A. albiterminata* n. sp. (length 3 mm.).
7. *A. ida* n. sp. (length 2 mm.).
8. *A. brunnea* n. sp. (length 1·1 mm.).
9. *A. fuscula* n. sp. (length 1·6 mm.).
10. *A. delicatula* n. sp. (length 1·2 mm.).

Genus **Atalophlebia** Eaton

2. Atalophlebia australis (Walk.)

This species, the genotype, has been fully dealt with by me in Part I. of this series of studies (Tillyard, 1934).

3. Atalophlebia superba, sp. nov.

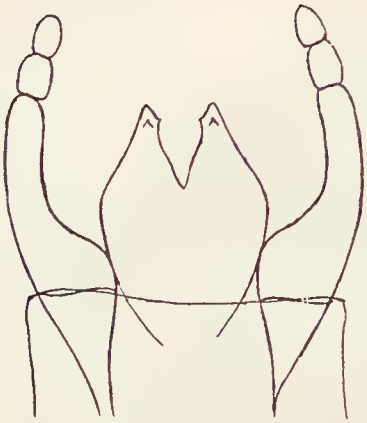
(Plate I, figs. 5, 6; text-figs. 4, 11, 17)

MALE IMAGO: Total length of body (dried) 10-12 mm.; abdomen 6-7 mm; forewing 11-12 mm.

Head: General colour dark chocolate brown, drying almost to black; eyes black; antennae very dark brown.

Thorax shiny, dark chocolate brown, drying almost to black; a pale short stripe on either side of prothorax, brownish or ochreous; underside very dark brown. Legs rich dark brown, the femora blackish apically; forelegs 10 mm. long, the femur and tarsus about equal, the tibia slightly longer; tarsal segments, in descending order of length, 2 = 3, 4, 5, 1 (partly fused with tibia); middle and hind legs much shorter, with order of tarsal segments 5, 2 = 3 =4, 1 (almost completely fused with tibia); tarsal claws both sharp, with narrow lateral flanges, much as in *A. australis* (Tillyard, 1934, pl. ii, fig. 6).

Wings with strong hyaline membrane, shiny, the veins from dark to medium brown, MA of forewing being the darkest. Bases of both wings clouded with dark brown, the forewing for 2 mm., the hind for less than 1 mm.; costal space of forewing heavily blotched with dark brown as far as the bulla, then more lightly tinted with brown around the pterostigmatic veinlets; basal portions of R_1 and Sc heavily blackened. *Forewing* (Pl. I, fig. 6) more stoutly built than that of *A. australis* (Pl. I, fig. 4), slightly broader, and the veins distinctly thicker, especially MA, the basal portion of CuA, the whole of CuP, and the anal veins. The general venational scheme of the forewing is closely similar to that of *A. australis*, but the posterior branches of CuA are more nearly parallel, and IMP extends further in towards the base than the fork of MA. Further, the wide gaps between the cross-veins shown in *A. australis* below R_2 and MP_1 are not present, and this, being the same in the subimago, causes the breaking-up of the complete lambda-pattern, owing to the development of pigment around the extra cross-veins. *Hindwing* (text-fig. 4) 4 mm. long, 2.5 mm. wide, with the costal hump more pronounced than in *A. australis*, the narrowed portion of the costal space much longer, reaching not



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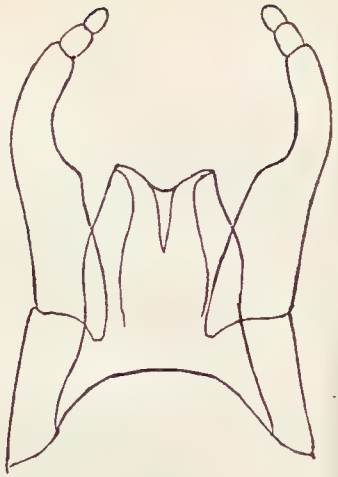

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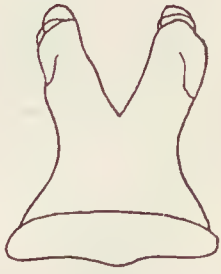

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Figs. 11-16.—Male genitalia of the genus *Atalophlebia*, dorsal views:

11. *A. syverha* n. sp. (× 75). 14. *A. brunnea* n. sp. (penis only; × 100).

far from apex, with a dozen or more costal veinlets present, two-thirds of them belonging to the narrowed portion; subcostal series of cross-veins complete, with a tendency to the formation of cross-struts between its middle members; Rs arising much closer to base than in *A. australis*; generally a fuller development of cross-veins everywhere in the wing; posterior margin less rounded than in *A. australis*, and with a faint embayment at end of MA.

Abdomen stout basally, dark chocolate brown, ringed with rich medium brown at ends of segments 2-9; spiracles surrounded with circlets of pale brown. *Genitalia* (text-fig. 11) brown, with three-segmented forceps, the first segment long and greatly narrowed for its distal half, the two distal segments nearly equal, short, subglobular; penis large and prominent, broadest near middle, deeply bifid, the two forks each carrying a small inner angle not far from apex, which is fairly sharply pointed also; just below each apex there is also a small denticle. Cerci long, 10-12 mm., brown, ringed narrowly with blackish at end of each segment; appendix dorsalis aborted.

Female Imago generally resembling the male, but with much smaller eyes and shorter forelegs; general colour dark brown, the wings not quite as heavily shaded as in the male; prothoracic lateral stripes larger; abdomen generally stouter. A small remnant of the appendix dorsalis usually present, about 0·5 mm. long and very slender; cerci as long as in male. Subgenital plate entire; subanal plate with a median triangular incision.

Subimago (both sexes) with the general body colouration dark fuscous, distinctly duller than in imago and not shiny; abdomen with pale segmental rings, clearer in male than in female. *Forewings* (Pl. I, fig. 5) heavily shaded with dark fuscous, so as to isolate an incomplete lambda-pattern; the presence of extra cross-veins with shading is the cause of the incompleteness of the lambda-mark. Hindwings shaded heavily with fuscous on all the cross-veins.

Nymph.—Total length of body 13-15 mm., cerci stout, 8·10 mm.; appendix dorsalis vestigial in male, 0·5 mm., slender, 7-9 mm., long in female but much paler than cerci. General colour dark brown, head and thorax almost black above, the latter with a more or less marked, mid-longitudinal stripe of brown or fulvous on mesonotum. Legs stout, femora dark brown, tibiae and tarsi medium dull fulvous above, all parts dull fulvous below; femur and tibia of equal length, tarsus less than half as long; tarsal claws somewhat stouter and less curved than in *A. australis*, denticulations very

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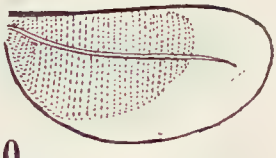

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Figs. 17-20.—Fourth gill-pair in nymphs of the genera *Atalophlebia* and *Baëtis:*

17. *A. superba* n. sp. (× 20).
18. *A. albiterminata* n. sp. (× 20).
19. *A. fuscula* n. sp. (× 67).
20. *B. frater* n. sp. (× 100). (Single gill.)

fine. *Gills* (text-fig. 17) seven pairs on segs. 1-7, all double, large and feathery, grey with blackish tracheae; in shape each gill is a broad, rather irregular, oval lamella with the apex trifurcate, each of the three forks being drawn out into a slender filament and provided with a stout trachea; main tracheal trunk stout, subdividing near halfway into three, one branch going into each fork; the main trachea gives off numerous branching tracheae on each side; the narrower of the two gills in each pair has the longest filaments. By comparison with the gills of *A. australis*, these gills are much larger and stouter, with more abundant lateral tracheae, and the apical filaments slenderer.

Types.—Holotype male, allotype female, type male and female subimagos, and type nymph all taken at the Penstock Lagoon, near Great Lake, Tasmania, on 29th January, 1933, by myself. Imagoes both bred from subimagoes; actual date of emergence, 31st January, 1933. All adult types pinned and set; nymph in spirit.

Habitat.—Great Lake, Shannon Lagoon, and Penstock Lagoon, Tasmania.

The nymphs were found in abundance under every piece of rotting wood in the lagoon, and were also dredged up in water-weed and detritus from the bottom. They are rather sluggish, and generally remain quiescent when removed from water; after a while they attempt to run away, and can travel quite fast; they are also quite good swimmers.

The subimago, locally known as the 'Penstock Brown,' emerges in hundreds on the Penstock Lagoon, and in smaller numbers on the Shannon Lagoon and Great Lake. The nymph rises far out in deep water, and the subimago emerges almost as soon as the nymph touches the surface of the water. The wings expand immediately, and the subimago floats on the water like a miniature, brown-sailed yacht. It makes no attempt to fly, but is drifted by the wind towards the shore. If the trout are feeding at the time, many fall easy victims to them; but many more reach the shores of the lagoon, where they at once seek shelter under the bark of near-by trees, under logs and rocks, and down near the roots of clumps of sedge or grasses. The time taken for the imago to emerge is from two to two and a half days.

A good way of ensuring emergence of the imagos is to put a layer of soft moss, not too moist, in a tin billy, and stand upright in the moss a number of stiff stems of sedges. The subimagos can be picked up by their wings and dropped into the billy, when they will at once take up positions on the sedge stems and will remain there until the imago emerges. If the lid is kept on, the humidity of the air inside will be just right to ensure the emergence without deformation.

A large number of paratype imagos, subimagos, and nymphs were secured at the same time as the types.

Var. **pallida.**— A very distinct variety of the subimago was found occasionally at Penstock Lagoon and, later on, more commonly on the Shannon Lagoon. In this the dark parts of the wings are replaced by an almost uniform pale greyish brown, so that the pale portions forming the broken lambda-mark are almost obliterated, and the wings appear very nearly unicolorous. Types of this variety were also taken on 27th January, 1933.

4. Atalophlebia hudsoni, sp. nov.

(Plate I, fig. 9; text-figs. 5, 12)

MALE IMAGO: Closely allied to *A. superba*, which it resembles in general size, form, and coloration. Only the male imago is known; it may be distinguished by the presence of a mid-longitudinal fulvous stripe on the mesonotum, by the different shading of the wings, the different shape of the hindwing, and by the colour of the abdomen.

Forewing (Pl. I, fig. 9) intermediate in colouring, and shading between that of *A. superba* and that of *A. australis;* the base is only moderately tinged with fulvous and the bulla only lightly indicated. The venational scheme comes closer to that of *A. australis* than that of *A. superba. Hindwing* (text-fig. 5), 3·5 mm. long, similar to that of *A. australis*, but somewhat larger and broader.

Abdomen a medium fulvous with darker markings on the spiracles, two interrupted and rather indistinct dorso-lateral darker bands separating a mid-longitudinal paler area, and paler rings around the ends of the segments.

Genitalia (text-fig. 12) rather closely similar to those of *A. australis*, but the forceps is more markedly narrowed after half-way, with a marked bulge on the inner margin; penis broader, more approaching the shape of that of *A. superba*, but with the lobes more like those of *A. australis*, though without the wide pockets seen in that species; instead, there is a deep cleft running backwards from the incision, very narrow. Cerci very long, 20 mm. or more, medium fulvous in colour; appendix dorsalis completely aborted.

Types.—Holotype male imago and three paratype male imagos, taken at Lake Leake, 26th February, 1933, by Mr. Eric Hudson, of Launceston, to whom this species is dedicated. Holotype and two paratypes in spirit; the third paratype dissected and mounted on slides in Canada Balsam.

I saw no sign of this interesting species when I visited Lake Leake on 9th February, so it is evidently late in emerging. As neither the female imago, nor the subimago nor the nymph, is known, we have to rely for the definition of the species purely on the male imago, which appears to me to be in many ways intermediate between *A. australis* and *A. superba*. In view of the fact that nymphs of *A. superba* have been transferred by anglers from the Penstock Lagoon to Lake Leake, with a view to improving the fishing, there seems to me to be a possibility that this form might be a natural hybrid between the two species, which would not otherwise intermingle, as far as is known, anywhere in Tasmania, *A. australis* being apparently confined to the Macquarie River watershed, and *A. superba* to that of the Great Lake and streams connected with it. But unless proof of this is forthcoming, it is better to consider *A. hudsoni* as a valid species.

5. Atalophlebia albiterminata, sp. nov.

(Plate I, figs. 7, 8; text-figs 6, 13, 18)

Male Imago: Total length of body 9-10 mm.; forewing 10-12 mm. General colour black, the thorax shiny above, with two fine whitish lines running forward on the mesonotum in front of the insertions of the forewings. Forelegs 8-10 mm. long, slender, blackish, the femora touched with brown in two places; tarsal segments in descending order 2, 3, 4, 5, (partly fused with tibia); middle and hind legs mostly medium brown, the femora strongly marked with black just before middle and for the apical one-fourth, the black and brown areas about equal; tibia blackish basally, brown distally; tarsus dark brown, the segments in descending order 5, 4, 3, 2, 1 (fused with tibia).

Wings hyaline, the *forewing* (Plate I, fig. 8) with black venation, the extreme base faintly yellowish, all the cross-veins in costal and subcostal spaces broadly shaded with black, the bulla carrying a large semi-circular blotch covering about two cellules, with a minute black spot forming a second bulla on R_2; the posterior margin of the forewing is more curved from MA to CuA than in the previous species and the cross-vein system considerably denser; the costa is narrowly basally and the brace-vein comparatively small. *Hindwing* (text-fig. 6) only 2·5 to 3 mm. in length, more triangular than in the previous species; R_1 tends to become slightly bent or broken, MP is very straight, not dichotomously forked; the cross-vein system fairly complete.

Abdomen black, usually with more or less distinct but very narrow pale transverse rings at end of each segment. Genitalia (text-fig. 13) of the general shape of *A. australis*, but with the lobes of the penis much more rounded, the incision between the lobes

short, triangular, the pockets quite separate, deep, and divided by a heart-shaped process on a short stalk. Cerci extremely long, 20-30 mm., stout, black, tipped for 3-5 mm. with white; in dried specimens, the ends of the cerci are usually pale buff or brownish; appendix dorsalis absent.

Female Imago generally resembling the male, but with smaller eyes and shorter legs, the body stouter and sometimes very dark brown instead of black, the size usually somewhat larger, forewing 11-13 mm. (A female specimen in my collection from Mount Kosciusko expands 28 mm., and is the largest specimen of the genus *Atalophlebia* known to me.) Tail-filaments three, approximately equal, 12-15 mm., the appendix dorsalis slenderer than the cerci.

Subimago with the general coloration dark fuscous (dull grey in many dried specimens); *forewing* (Plate I, fig. 7) pale greyish, with a more finely mottled pattern than in that of any of the previous species, there being a large number of shaded cross-veins, and the terminal veinlets being more numerous and more heavily shaded; very little of the lambda-pattern can be made out, owing to its being broken up by shaded cross-veins; *hindwing* with all cross-veins shaded, the subcostal series heavily so.

Nymph: Total length of body 10-13 mm., tail filaments 12-15 mm. General colour either dark brown, dark fuscous, dark grey, or black, according to the colour of the débris in which it is living. *Head* with two very pale, squarish patches between eyes and lateral ocelli and a pale triangular patch on median ocellus; *eyes* black; antennae 3 mm., slender, filiform, multi-articulate, pale greyish brown. Mouth-parts closely resembling those of *A. australis* (Tillyard, 1933, pl. ii, figs. 13-18), but with the following slight differences:—labrum with shallow median incision carrying five distinct, flatly rounded processes; mandibles not quite as broad as in *A. australis*, the incisors longer and more pointed, three in the outer group in each mandible, two in the right inner, one large, sharp one in the left inner; tufts of the prostheca somewhat thicker; maxillae with first and second segments of palp subequal; labium with larger laciniae and with second and third segments of palp equal. *Thorax* almost uniformly dark all over; legs semi-transparent brownish, very strongly particoloured, there being two large dark patches on each femur, one near middle and one occupying the apical fourth, together with an extra basal patch on hind femur; tibia darkened at base and beyond middle, apex pale; tarsus dark from one-fifth to three-fifths from base; tarsal claw with finely denticulate inner margin. *Abdomen* dark, the segments marked with a variable pattern of pale greyish or brownish, which may best be described by stating that the anterior and posterior margins of each segment are pale, and the dark colour appears to be partially

divided up into three contiguous blocks whose projecting posterior ends are more or less squarish or sometimes rounded off; tail-filaments medium brownish or fuscous, the principal segments marked off by black rings, but each segment is again subdivided into two, three, or four annulations or subsegments, each very short and only indicated by slightly darkened rings; the more basal segments are short, the more distal much longer. *Gills* (text-fig. 18) pale, greyish, with black tracheae; large, wide, and multi-digitate, with from 7 to 15 slender filaments; the shorter gill is the broader of the two.

Types.—Holotype male imago, allotype female imago, male and female type subimagos and type nymph, all taken on Lake Echo, Tasmania, on 5th February, 1933, by myself, together with a long series of paratypes of both adults and nymphs. Type adults pinned and set, nymphs in spirit; two adult paratypes and two nymphal paratypes dissected and mounted on slides in Canada Balsam.

Habitat.—All over Tasmania and the eastern highlands of Australia, in stagnant or still waters or in backwaters of rivers.

This species is geminate to *A. costalis* Burm., found along the coastline of Eastern Australia (Queensland and N.S.W.), and has closely similar habits. These are the only two species known to me whose nymphs can exist in absolutely stagnant water and appear to prefer it to any other location. The nymphs are usually dredged up with the bottom mud or débris, but are sometimes found in masses of tangled water-weed, or under logs, stones, or rocks in stagnant backwaters; they do not occur where the current is moving at all. The mottled coloration of the legs appears to be 'camouflage'; the multiplication of gill-filaments appears to be correlated with the added difficulty of breathing in stagnant water.

It should be here noted, in passing, that the figure given by me as that of the nymph of *A. costalis* Burm. (Tillyard, 1926, p. 60, fig. E3) is not that of this species, but belongs to a large, undescribed species; the larva of *A. costalis* resembles that of *A. albiterminata* fairly closely and has somewhat similar gills.

As regards the adults, the males may be seen commonly in quiet backwaters, particularly in dull weather or late in the afternoon, performing their graceful evolutions over the water. The flight of the male consists of a long, swinging pendulum motion, usually performed quite close to the water, with the long tail-filaments held out fairly wide apart behind, their white tips being plainly visible. It is seldom that one sees more than six or seven of these insects flying together, often only one or two. They are easily alarmed, and disappear with startling suddenness, apparently becoming suddenly invisible when they swerve away from their swinging flight. The subimagoes may often be seen sitting on the stems of reeds, especially during dull or stormy weather, and can then be

easily collected by picking them off with the hand; if the same is attempted with the imago, it usually drops from the reed-stem with a quick motion. The subimagos of this species in Tasmania have the wings more definitely and beautifully mottled than those of the mainland, but there do not appear to be any other differences.

6. Atalophlebia ida, sp. nov.

(Plate I, fig. 10; text-fig. 7.)

Female Imago: Total length of body 8-10 mm., forewing 12 mm., cerci about 12 mm. *General coloration* strongly mottled in brown and black. Head (shrivelled) black with bright brown markings. Thorax rich brown shading to black; legs medium brown, with femora black just beyond halfway and also at apex; tarsal segments in descending order, 2 = 3, 4 = 5 (1 fused with tibia).

Forewing (Pl. I, fig. 10) with rather delicate hyaline membrane, dark brown veins, heavily spotted with black; all the costal veinlets and cross-veins in the subcostal space are surrounded by wide oval or rounded black patches, as are also the fewer cross-veins just below R_1, most of those between Rs and MA basally and also between MA and MP. Around the bulla there is a large irregular black patch covering the width of two cellules, and a somewhat similar large patch covers the cross-veins around the fork of MA. Cross-vein system, on the whole, rather open; the wing distinctly narrower than in the preceding four species, with less prominent tornus. *Hindwing* (text-fig. 7) small, barely 2 mm. long, veins delicate, brownish; shape rather elongate oval, the costal hump very pronounced, and followed by a minute notch; costal space comparatively narrow basally and devoid of veinlets; about nine costal veinlets placed distally, three being close together below the notch; subcostal space wide, with complete series of cross-veins, about seven in number; very few cross-veins in posterior portion of wing.

Abdomen mottled in brown and black; in lateral view, the abdomen appears at first sight as if ringed with black on each segment; but, seen more closely, each segment carries a black mark shaped somewhat like a capital R, the loop being small and the lower stroke lengthened. *Tail-filaments* three, subequal, blackish, narrowly ringed with pale brown at end of each segment. Subgenital plate entire, projecting slightly in middle. Subanal plate prominent, projecting beyond end of abdomen, deeply bifid, the two projecting halves pointed, curving inwards distally, and separated by a deep oval cleft.

Male Subimago closely resembling the imago, but with the wings pale opaque greyish; forewing with the spots along the costal and subcostal spaces blackish, but the rest of the mottling only medium grey; tail-filaments three, about 15 mm. long, greyish.

Nymph unknown.

Types.—Holotype female imago, taken at Dee Bridge, between Lakes Echo and St. Clair, Tasmania, on 7th February, 1933, by myself, together with five paratype female imagoes. Type male subimago taken by myself on Lake St. Clair, 6th February, 1933. All pinned and set except one paratype, which was dissected and and mounted on slides in Canada Balsam.

The specific name is taken from Mount Ida, near Lake St. Clair.

Habitat.—Upper reaches of River Dee; also Lake St. Clair, Lakes Lilla and Dove (Cradle Mountain, N.W. Tasmania). The insect was first seen by me on 6th February, drifting far out over Lake St. Clair; several were captured from a boat by striking them down into the water with a net; these were all subimagos, and were mostly badly damaged. The following day the type series was secured by beating bushes overhanging the stream at Dee Bridge; but no male imagos could be found. The specimens from Cradle Mount are considerably smaller (forewing 10 mm.) and less spotted,

Fig. 21.—*Atalophlebia brunnea* n. sp. Forewing. Length 6 mm.

the patch covering the fork of MA being reduced to a very small size or even to a point, while the rest of the spots on the forewing more closely resemble those of the male subimago described above. The Cradle Mountain series consists of four male and one female imago taken by me in January, 1917; but I prefer to await the discovery of a male imago from the type locality before describing it.

7. Atalophlebia brunnea, sp. nov.

(Text-figs. 8, 14, 21)

Male Imago: Total length of body 6 mm.; forewing 6 mm.; cerci 10-11 mm. General colour brown.

Head dark brown; eyes subdivided into two portions, the larger and upper being pinkish brown, the smaller and lower dark grey; antennae pale; ocelli transparent, whitish, the lateral ones swollen, hemispherical globes on dark brown bases.

Thorax dark brown above, a faint indication of a pair of darker longitudinal stripes on mesonotum. Legs medium brown, knee-joints and ends of tibiae slightly darkened; forelegs 5 mm. long, tarsal segments in descending order of size 2, 3, 4, 5, 1 (partly fused with tibia); middle and hind legs much shorter, tarsal segments in descending order 5, 2, 3 = 4 (1 fused with tibia).

Forewing (text-fig. 21) hyaline with semi-transparent brownish venation, C, Sc, and R_1 darker than the other veins, especially in region of the pterostigma, which is also faintly tinted with brown on the membrane; costal veinlets absent except for a series of about eight in the pterostigma; subcostal cross-veins also absent from base to beyond halfway; rest of venation moderately open; basal portion of anal area with very faint veins; posterior margin before tornus very slightly concave. *Hindwing* (text-fig. 8) very small, 1·1 mm., costa stout, meeting Sc at about three-fifths; costal space without veinlets except for three short ones beyond the hump; four subcostal cross-veins, of which the last two continue the lines of the last two costal veinlets downwards; two cross-veins below R_1 and one blow MA, but no other cross-veins in the wing.

Abdomen pale, semi-transparent brown from base to end of seg. 7; seg. 8 medium brown, 9-10 darker brown; sutures between most of the segments pale, a black spot on each stigma. Genitalia (text-fig. 14) pale buff, with three-segmented forceps, the first segment long, the other two small and globular; penis with slightly diverging lobes separated by a deep semi-circular embayment; each lobe irregularly truncated. Tail-filaments three, equal, pale buff, slightly darker at bases.

Female Imago, Subimago, and Nymph unknown.

Types.—Holotype male imago and two paratype male imagines, all taken at Clarendon, Northern Tasmania, on the South Esk River, by Mr. Eric Scott, of Launceston, on 9th March, 1933. Holotype and all except tip of abdomen of one paratype in spirit; the other paratype and the cut-off tip of abdomen dissected and mounted on slides in Canada Balsam.

A similar but considerably larger insect was bred by me from a nymph taken in the Shannon River, near the Great Lake, in February, 1933. I also have two specimens rather closely similar to the holotype, taken at Hobart and Mount Wellington respectively in 1917, but these have a faint series of costal veinlets before the pterostigma. Pending the discovery of more abundant material, it seems wise to leave these undescribed.

8. **Atalophlebia fuscula**, sp. nov.

(Text-figs. 9, 15, 19, 22)

Male Imago: Total length of body 7·8 mm.; forewing 7-8 mm.; tail-filaments 10 mm. General colour black.

Head black.

Thorax black: Legs chiefly black, but hind femora mostly dark brown, tending to black at apex; forelegs 6·5 mm., tarsal segments in descending order 2 = 3 = 4 (all fairly long), 5, 1 (partly fused with tibia); middle and hind legs rather long, tarsal segments in descending order 5, 1 = 2 = 3 = 4 (1 fused with tibia).

Wings hyaline, with dark brown venation, rich russet brown at bases of C, Sc, and R of forewing together with brace-vein. *Forewing* (text-fig. 22) with slight fuscous tinting of membrane at pterostigma; costal series of veinlets complete, but very weakly chitinized and widely spaced before pterostigma, there being only about six such veinlets, with about ten much more strongly chitinized and closely spaced in pterostigma; subcostal cross-veins slightly more numerous in basal half, but fewer beneath pterostigma. There are three bullae, in the form of minute circular clear areas in slight swellings of the main veins, as follows: anterior bulla on Sc at about three-sevenths

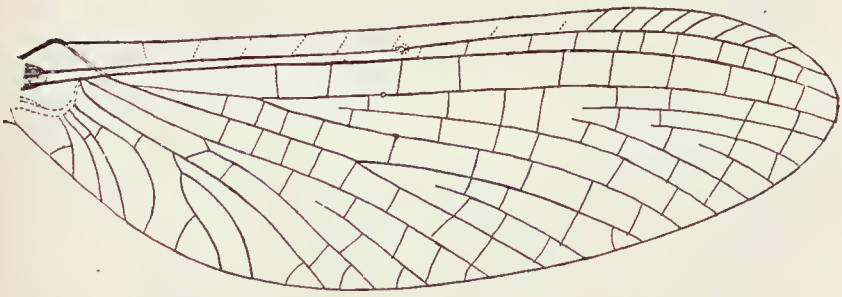


Fig. 22.—*Atalophlebia fuscula* n. sp. Forewing. Length 8 mm.

from base; middle bulla on R_2, slightly basad from level of anterior bulla; posterior bulla on R_{1+5} at junction of cross-vein descending on to fork of MA or close to it, i.e., either at level of anterior bulla or of middle bulla. The anterior bulla usually has slight clouding around it, but the others resemble tiny knots in the veins, with clear holes (membrane) in the middle Anal veins pale. *Hindwing* (text-fig. 9) 1·6 mm., somewhat larger than that of *A. brunnea*, the apex more pointed, the hump somewhat more prominent, the narrow distal portion of the costal space longer, with four veinlets; no veinlets in basal portion of costal space; four long cross-veins in the wide subcostal space, three in the radial, one connecting fork of Rs with MA and one below MA.

Abdomen black, marked with a pattern of dark brown, of which the areas decrease in size from seg. 2 to end of abdomen; segs. 2-4 with approximately the basal half dark brown, then the amount of brown decreases until on seg. 8 it is only a narrow basal ring;

segs. 9-10 black, 10 rather large; underside brown. Genitalia (text-fig. 15) with the forceps three-segmented, the first segment very long, narrowed about halfway by a marked inbending of the inner margin; the second segment distinctly longer than the third, subcylindrical, the third globular. Penis turned upwards, its lobes separate, cylindrical, irregularly truncated at apex, which is divided into two blunt lobes, with a third lobe arising on the inner side and not reaching the level of the apex; this inner lobe carries a small, blunt triangular tooth. Tail-filaments three, subequal, about 10 mm long, dark fuscous; very easily broken off.

Female Imago closely similar to male, but usually somewhat larger and with stouter abdomen; legs rather long, but forelegs not quite as long as in male. *Forewing* 8 mm.; *hindwing* somewhat larger than in male, with more numerous cross-veins in the posterior portion, there being usually three or four below MA.

Subimago generally similar to imago, except that the black coloration is much duller; *wings* a medium opaque slate-grey in the pinned specimen, but appearing almost black in the living insect at rest.

Nymph: Total length of body 7-8 mm.; tail-filaments 10 mm. General colour blackish above, yellowish buff beneath. *Head* blackish tending to dark brown on occiput; eyes grey-black; antennae pale greyish; three pale yellowish or whitish spots cover the ocelli. Mouth-parts differ from those of *A. australis* as follows:—labrum very slightly incised in the middle of the outer margin; mandibles with the incisors much slenderer, ending in two to three teeth in each group, the right mandible with the projecting area far separated from the molar area and ending in a hardened black tubercle; maxillae comparatively short and broad, the inner lobe very wide and not as square in shape as in *A. australis*, the palp comparatively short, the first segment rather broad and almost as long as the second and third taken together, the second cylindrical, the third slightly longer, pointed, with a brush of apical hairs; labium with galea less broad than in *A. australis*, laciniae very small and rounded, palps with the first segment longest and broadest, the other two subequal. *Thorax* dark brown above, mesonotum with two pale yellowish-brown marks above apex, apex itself tipped with blackish; wing-sheaths dark brown (black before emergence); legs somewhat hairy, medium brown, semi-transparent, femora with a dark line along dorsal ridge, longer than tibia, apex fuscous; tibia slender, three-fourths the length of femur; tarsus one-third as long as tibia; tarsal claw small, very strongly denticulate. *Abdomen* rather elongate, tapering from base to anal end, black above, with a mid-longitudinal row of pale yellowish-brown markings, triangular on the more basal segments, but becoming broader and more distinct posteriorly, until on seg. 10 the brown colour covers all but the

posterior margin of the segment; seg. 10 with three posterior angles, one at its apex and two postero-lateral; there are also faint indications of a smaller series of brown spots along the sides, one pair on each segment, increasing in size posteriorly; lateral flanges small, hooked posteriorly, semi-transparent yellowish-brown, touched with black at the gill-insertions; underside dull yellowish. *Gills* (text-fig. 19) double, seven pairs, on segs, 1-7, increasing in size from 1 to 4, then decreasing to 7; each lamella is narrowly lanceolate and ends in a long, slender filament; colour pale, semi-transparent brownish, with stout blackish tracheal trunk and short, stumpy lateral tracheal twigs.

Types.—Holotype male imago, allotype female imago, type male and female subimagos and type nymph, also long series of paratypes of both adults and nymphs, taken by myself on the River Shannon, Tasmania, near the bridge on the road leading from the Great Lake to the Penstock Lagoon, on 27th January, 1933.

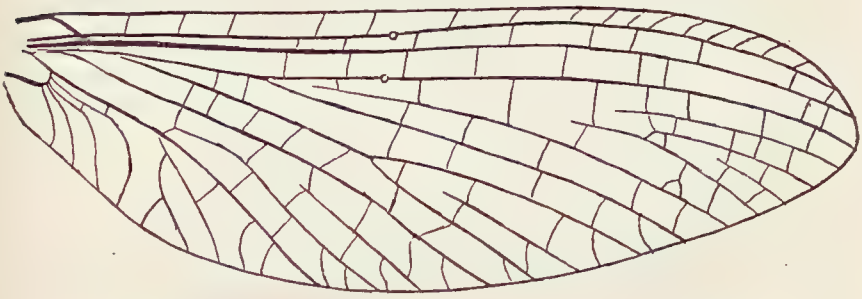


Fig. 23.—*Atalophlebia delicatula* n. sp. Forewing. Length 6 mm.

Habitat.—Fast-running streams in many parts of Tasmania and the highlands of Eastern Australia, including Mount Kosciusko up to about 5000 feet. The imagos may be seen flying in the air in considerable numbers with a typical 'spinning' flight; the subimagos sit about on bushes, reed-stems, &c., and are very conspicuous; they can also be found in numbers hiding on the undersides of large rocks, &c. The nymphs are very active, and cling to the undersurface of rocks in a fast current; when disturbed, they run with great agility.

9. Atalophlebia delicatula, sp. nov.

(Text-figs. 10, 16, 23)

Male Imago: Total length of body 5 mm.; forewing 6 mm.; tail-filaments 9 mm. *General colour* blackish.

Head black; eyes large, globular, black; antennae very short, dark brown.

Thorax black; legs long, dark brown, the apices of femora and tibiae blackish; forelegs 5 mm., tibia slightly longer than femur, very slender; tarsal segments in descending order 2, 3, 4, 5, 1 (partly fused with tibia); middle and hind legs fairly long, tarsal segments in descending order 5, 1 (fused with tibia), 2, 3, 4.

Wings hyaline, with delicate, dark brown to blackish venation. *Forewing* (text-fig. 23) 6 mm., brace-vein and bases of C, Sc, and R_1 russet brown; at first sight there are apparently no veinlets in the costal or subcostal spaces until the region of the pterostigma, but, under careful lighting, a few pale, semi-transparent veinlets can be made out (more easily in the female), some of which may be incomplete; about six well-developed slanting veinlets in the pterostigma, with four or five more widely spaced in the subcostal space beneath; there are only two bullae, the anterior just short of midway along Sc, and a second, slightly basad from this level, on R_2; each bulla is a small circular hollow in the vein, with hyaline centre; anal veins pale, anal margin slightly thickened. *Hindwing* (text-fig. 10) 1·2 mm., costal hump rather inconspicuous, not very wide basally, with only two veinlets, both in the short, narrowed distal end of costal space; subcostal space wide, with three cross-veins; bases of Rs and MA missing; one supporting cross-vein above Rs, two above MA, and one below; no cross-veins in posterior half; general shape well rounded.

Abdomen grey-black, with a pattern of greyish markings, only clear on the middle segments, each of which has a pair of pale longitudinal curved lines separating a median dark stripe. Genitalia (text-fig. 16) with the forceps three-segmented, the first segment long, stout basally, tapering strongly distally, the other two segments short, subequal, oval; penis small, its lobes separated by a deep cleft, each lobe stout, irregularly truncated, with three terminal rounded embossments and a larger rounded process projecting slightly inwards not far from apex. Tail-filaments three, subequal, grey, the segments ringed apically with black.

Female Imago closely resembling the male, but generally slightly larger, body stouter, forelegs somewhat shorter; forewings usually with a few more pterostigmatic veinlets; subgenital plate entire, subanal plate apparently strongly projecting, slightly truncate at tip and hollowed out.

Subimagos resemble the imagos, except that the body coloration is a dull greyish black and the wings are slightly opaque pale fuscous, with the cross-veins narrowly shaded in darker fuscous, so as to produce an appearance of mottling, most noticeable in the living insect when at rest.

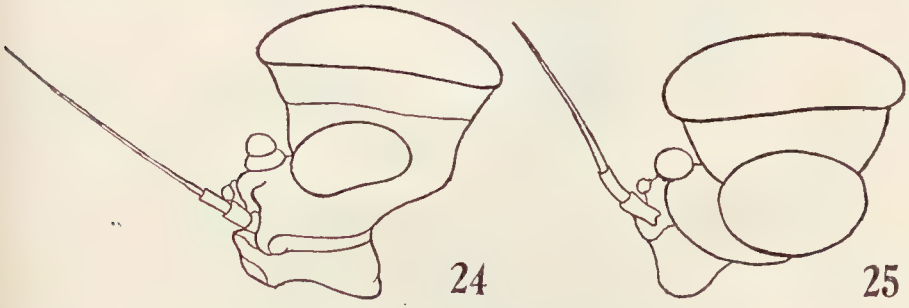
Nymph unknown.

Types.—Holotype male imago, allotype female imago, type male and female subimagos, also two male paratype imagos and three paratype subimagos, all taken by myself on the North Esk River, near Perth, Tasmania, on 21st January, 1933. All pinned and set.

Habitat.—Northern Tasmania, in moderately flowing rivers. North Esk and Macquarie Rivers. Probably common if searched for.

Family BAËTIDAE

In this family the species are all of rather small size, the forewings being from 4 to at most 12 mm. in length. The hindwings are either absent or excessively small, with very little venation. The most outstanding character in the family is the development of the compound eyes in the males; these are divided into two quite distinct parts, a lower and outer normally oval or rounded part, usually darkly pigmented, and a huge upper and inner portion, raised on a broad pedestal, and known as a 'turban eye' from its marked resemblance to a turban; this part of the eye is usually pale in colour. (See text-figs. 24, 25.)



Figs. 24-25.—Turban-eyes in the males of Baëtidae:
24. Lateral view of head of *Baëtis frater* n. sp. (× 50).
25. Lateral view of head of *Cloëon tasmaniae* n. sp. (× 50).

In the forewing, the cross-vein system is usually (but not always) greatly reduced; the anal system of veins is reduced in correlation with the great reduction or total loss of the hindwing, while, at the same time, the anal area is somewhat broadened and the anal border more or less well rounded. The middle branches of all triads (interpolated veins) are disconnected at their inner ends, except, in some cases, IR_{3+4} and ICuA; MA_2 and MP_2 are also usually similarly disconnected. Along the whole of the posterior margin, from CuP to apex, there is developed a complete series of short, marginal veinlets, in between the branches of the main veins; these may be single (Cloëon), or in sets of two or three.

Of the three caudal setae, the middle one (appendix dorsalis) is aborted; the other two (cerci) are usually much longer than the body.

Two cosmopolitan genera are represented in Tasmania, and may be distinguished as follows:—

Hindwing present, exceedingly small; forewing with the marginal veinlets in sets of two or more .... Genus *Baëtis* Leach.

Hindwing absent; forewing with the marginal veinlets single .... Genus *Cloëon* Leach.

Fig. 26.—*Baëtis frater* n. sp. Male. Complete insect, lateral view, with tail-filaments cut short. (× 11.)

Genus **Baetis** Leach.

10. Baëtis frater, sp. nov.

(Text-figs. 20, 24, 26-28)

Male Imago, Subimago, and Female Imago unknown: Length of body, 4·5 mm.; forewing 4·5 mm.; hindwing 0·6 mm.

Head dark brown; antennae brown; compound eyes dark fuscous, the turban-eyes pale buff; ocelli transparent.

Thorax dark brown. Legs whitish; forelegs 4 mm. long, very slender, tibia twice as long as femur, tarsus one and a half times as long as tibia; segments of tarsus, in descending order of length, 2, 3, 4 = 5, 1; middle and hind legs short, the tarsus only four-segmented, the segments in descending order of length being 1, 2 = 4, 3.

Forewing (text-fig. 26) 4·5 mm. long by 1·6 mm. wide, hyaline with white veins and slightly opaque, cream-coloured pterostigma. Venation as in text-fig. 26; from seven to nine pterostigmatic veinlets, irregularly placed, the first two or three very faint; two

cross-veins between R_1 and R_2; and two below R_2 basal ends of R_{2+3} and IR_{3b}, connected with main veins above and below; a cross-vein joining IR_{3b} to MA_1 across R_{1+2}; faint cross-veins below basal ends of IMA, MA_2, IMP and MP_2; ICuA connected basally with CuA and CuP. Marginal veinlets in sets of two. *Hindwing* (text-fig. 27) excessively reduced, 0·6 mm. long, with a strong costal knob or hump, one fairly strong vein (R_1) and four very weak veins.

Abdomen slender, segments 1-6 lightly chitinized, pale, whitish, a tinge of pale brown on tergites; segments 7-10 much more heavily chitinized, dark brown. Genitalia with the limbs of the forceps four-segmented; the basal segment short and broad, the second and third not very clearly separated, slender and much longer, the fourth small, narrow pyriform. Penis retracted, its lobes broad, flattened, rather bluntly pointed. *Cerci* 3 to 4 mm. very slender, with about 50 cylindrical segments, mostly 5 to 6 times as long as wide.

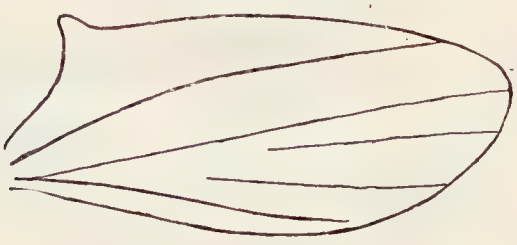


Fig. 27.—*Baëtis frater* n. sp. Hindwing. (× 100.)

Nymph (text-fig. 28): Length of body 6 to 7 mm.; cerci 3 to 4 mm., antennae 3 mm., pale buff, with more than 30 segments; appendix dorsalis slightly shorter. General colour a medium brown, the head somewhat darker, the eyes dark-grey; mouth-parts and legs pale buff; last segment of abdomen and tail-filaments pale buff; gills semi-transparent tinged with buff. There is a slight pattern dorsally on the thorax, consisting of a pale mid-longitudinal line, bordered on each side by a narrow stripe of dark brown, which is joined posteriorly by a more laterally placed, oblique, broader dark stripe on each side. The extreme base of each abdominal segment is narrowly ringed in pale buff. The mouth-parts, femora, tibiae, and tarsi are touched distally with fuscous. Viewed laterally, the abdominal tergites are dark brown, the sternites pale buff. Legs short, with rather stout femora, slender tibiae somewhat shorter than femora, tarsi about same width as tibiae but shorter. Gills (text-fig. 20) seven pairs, on abdominal segments 1-7, the first pair very small, the third and fourth pairs largest, those of segs. 6 and 7 much smaller than 5; each consists of a single oval lamina, of which the outer (anterior) margin is fairly straight, the inner well rounded; each carries a single tracheal trunk, situated

somewhat closer to the anterior than to the posterior margin; the anterior and basal parts of the lamella are of tougher consistency than the inner and distal, and are darkened with a fine brownish granulation; both anterior and inner margins are somewhat thickened, especially the former. The cerci are narrowly fringed on the inner side only, the appendix dorsalis is similarly fringed on both sides.

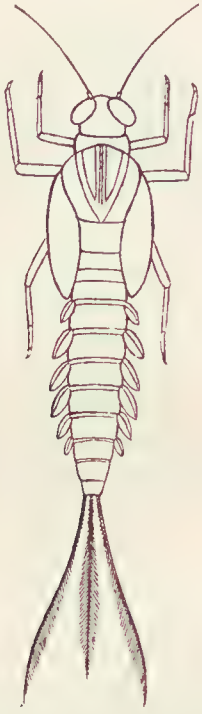


Fig. 28.—*Baëtis frater* n. sp. Full-grown nymph (male). Length, excluding tail-filaments, 6 mm.

Types.—Holotype male imago and type nymph, both taken together by myself on a small creek near Weldborough, North-Eastern Tasmania, together with numerous paratypes of male imagos and nymphs. All in spirit. The adults were flying in small groups a yard or two above the water; the nymphs rested on the sandy or gravelly bed of a fairly fast-running creek.

This species appears to be rather closely related to *B. soror* Ulm, from Western Australia, but can be at once distinguished from it by its smaller size, pale abdominal segments 1-7, and pale costa and subcosta without any darkening of the costal and subcostal spaces. In the venation, *B. soror* has a much more extensive series of costal veinlets occupying the whole of the distal half of the costal space, and the marginal veinlets are single along the basal half or

more of the posterior margin, then double to apex. The hindwing in *B. soror* has the costal projection ending in a sharp angle, not in a rounded hump as in the new species. Also the cerci in *B. soror* are faintly ringed with dark at the end of each segment.

Fig. 29.—*Cloëon tasmaniae* n. sp. Male. Complete insect, lateral view, with tail-filaments cut short. (× 11.)

Genus **Cloëon** Leach.

11. Cloëon tasmaniae, sp. nov.

(Text-figs. 29, 30)

Male Imago (text-fig. 29) : Length of body 7 mm., forewing 6 mm., cerci 12 mm., foreleg 5·2 mm.

Head pale brown; antennae whitish; compound eyes dark fuscous, the turban-eyes pale buff tinged with pink.

Thorax medium brown, paler beneath. Legs whitish; foreleg with femur about 1·2 mm. long, not very stout, tibia 1·6 mm., slender, tarsus 2·2 mm., the segments in descending order of length being 2, 3, 4, 5, 1; middle and hind legs short, segs. 1 and 2 fused together; in descending order the lengths of the segments are 1 + 2, 3 = 5, 4.

Forewing (text-fig. 29) 6 mm. long by 2·4 mm. wide, hyaline (except for the costal and subcostal areas, which are opaque) pale cream-coloured, deepest on pterostigma; veins very pale buff, except R_1, which is whitish except at its distal end. Pterostigma with about five veinlets well spaced apart. Branches of main veins all disconnected basally, but supported by a number of cross-veins arranged as shown in text-fig. 29. Marginal veinlets single. *Hindwing* absent.

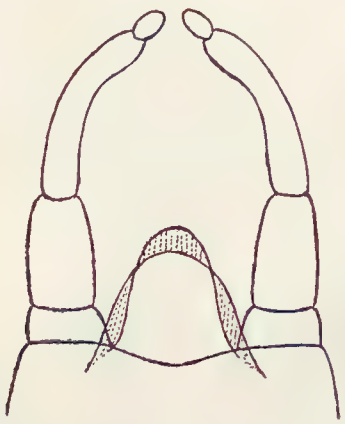


Fig. 30.—*Cloëon tasmaniae* n. sp. Male genitalia, dorsal view. (× 100.)

Abdomen pale yellowish brown darkening to medium brown on segs. 7-10; no definite pattern. Genitalia (text-fig. 30) whitish, the limbs of the forceps four-segmented, the first segment short and stout, the second somewhat longer, fairly stout, the third slenderer, thrice as long as the first, the fourth a minute knob; penis a pair of minute projecting lobes, barely visible. Cerci extremely long and slender, 12·5 mm., with more than forty segments, whitish, the joints slightly darkened; appendix dorsalis vestigial.

Female Imago generally of same size as male, but differing in its slightly darker coloration, the head and thorax being somewhat darker brown; no turban eyes present; cerci and forelegs shorter.

Subimago (both sexes) similar to imago in general form and size, but with general body-colouring pale creamy buff; compound eyes fuscous, ringed with creamy white; turban-eyes of male smaller than in imago, cream-coloured. Wings with the membrane slightly opaque, milky white, the veins whitish.

Nymph unknown.

Types.—Holotype male imago and allotype female imago from the Macquarie River, Stewarton, Tasmania, 8th February, 1933, taken by Mr. Eric Scott; type subimagos, male and female, from

same locality, 5th March, 1933, taken by Mr. B. Plomley. Also a series of paratypes, three male imagoes, and eight subimagoes.

This interesting species of a cosmopolitan genus is the first purely Australian species of the genus *Cloëon* to be described, the other being *C. viridis* Klap., found in Java, Sumatra, and North-Western Australia. A species closely allied to *C. tasmaniae* n. sp. is known to occur also in the mountains of Eastern Australia, but has not yet been described. *C. tasmaniae* n. sp. agrees with all the Indo-Malayan species in having the costal and subcostal areas of the forewing distinguished from the rest of the wing by special coloration, but not so markedly, for instance, as in *C. viridis* Klap. or in *C. samoënse* Till. The creamy-buff subimagoes are very striking.

Family CAENIDAE

(*Brachycercidae* Lestage)

It should be noted that Lestage has changed the spelling of *Caenis* Leach to *Coenis*, and, later, has suppressed this name as a synonym of *Brachycercus* Curtis, at the same time changing the well-established family name to Brachycercidae. As no other authors have followed him in these alterations, I propose to keep to the name *Caenis*, pending a full investigation of the problems of nomenclature involved.

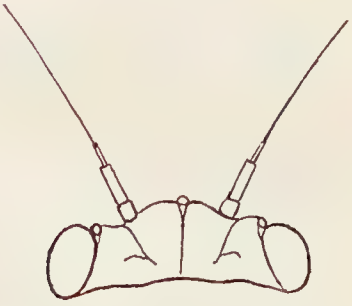


Fig. 31.—*Caenis scotti* n. sp. Head, dorsal view. (× 67.)

In this family the species are all of small to very small size, some being the smallest known Mayflies, the forewing of one species being only 2 mm. long. The hindwings are absent in almost all cases. The family can be at once distinguished from the Baëtidae by the form of the compound eyes (text-fig. 31), which are button-like and placed wide apart in both sexes. The anal area of the forewing is expanded and well rounded, usually even more so than in the Baëtidae, and there is usually only a single

anal vein, more rarely two. The branches of the main veins, including the middle members of triads, are either all or mostly complete basally; the cross-vein system is greatly reduced (almost entirely absent in *Caenis* itself). The nymphs (not yet discovered in Tasmania) have shorter and somewhat stouter bodies than the nymphs of Baëtidae, and can be distinguished at once by the fact that the gills of the second segment of the abdomen form a pair of stiff gill-covers or opercula, completely protecting the succeeding pairs of gills on segments 3 to 6. The caudal filaments are stiff, filiform, hairy, but not fringed as in Baëtidae.

The two Tasmanian genera may be distinguished as follows:- -

Wings not exceptionally broad; ratio of length to breadth approximately 3 : 1	Genus *Tasmanocoenis* Lestage
Wings exceptionally broad near base; ratio of length to breadth 2 : 1 or even less	Genus *Caenis* Leach

Genus **Tasmanocoenis** Lestage

This genus has the wings only slightly dilated in the anal region; A_1 stands well apart from CuP basally, but the latter vein curves distally towards it again; A_1 itself is slightly sigmoid. Lestage gives no figures, so it is difficult to picture what the insect is like.

Genotype.—Tasmanocoenis tonnoiri Lestage.

12. Tasmanocoenis tonnoiri Lestage

This small Mayfly, with a forewing 5 mm. long, was described from a single male imago taken by Mr. A. L. Tonnoir at Geeveston, Tasmania, on 7th December, 1922. The type is in Brussels.

Genus **Caenis** Leach.

13. Caenis scotti, sp. nov.

(Text-figs. 31-33.)

Male Imago: Length of body 3·4 mm.; forewing 3·4 mm.; foreleg 2·6 mm.; caudal filaments about 9 mm.

Head short, wide, more than thrice as wide as long; compound eyes black, placed laterally, almost as long as the head itself; median ocellus small, on a slight median prominence in front; lateral ocelli also small and contiguous with the inner margin of the compound eyes; antennae pale brownish, about as long as the head is wide, the scape short and stout, the pedicel about twice as long, fairly stout, the first distale stiff, slender, about half as long as the pedicel, the remainder of the antenna consisting of an extremely delicate, transparent filament.

Thorax extremely large and stout, heavily chitinized, dark brown to blackish. Prothorax short, not quite as wide as head; ventrally it carries an inverted V-shaped mark, edged posteriorly with a black line. Mesothorax immense, occupying almost the whole of the thorax; metathorax very short, attached closely to mesothorax behind; sternites pale. Legs pale brownish; forelegs 2·6 mm., femur rather short, tibia and tarsus each about thrice as long as femur; lengths of tarsal segments in descending order 2, 3, 4, 5, 1; middle and hind legs much shorter, tarsal segments in descending order of length 1, 5, 2, 3 = 4; tarsal claws alike in foreleg, both globular, unlike in middle and hind legs, one blunt and one sharp.

Forewing (text-fig. 32) 3·4 mm. long by 1·8 mm. wide; completely hyaline, except for pterostigma, which is milky; veins white, except

Fig. 32.—*Caenis scotti* n. sp. Forewing. Length 3·9 mm.

Sc and R_1, which are dark purplish to pterostigma. Venation typical for the genus (text-fig. 32); all the branches of the main veins complete basally; IR_2 attached basally both above and below; R_3 arising from IR_2; IMA arising from MA_1, IMP from MP_2. Two short subcostal cross-veins are present near middle of Sc; the first of these is continued obliquely backwards and downwards to R_2; about one-third from base, there is a cross-vein between IR_3 b and R_{1+3}, and another joining MA_2 near its origin to MP_1; still closer to base, the posterior fork of CuA is joined by a cross-vein to CuP. CuP and A_1 between them isolate a narrow, bottle-shaped area with bent neck. *Hindwings* absent.

Abdomen short, stout basally, tapering from segment 1 to 4, then cylindrical to 9; 10 narrower, closely attached to 9. Colour pale to medium brown, segs. 8-10 much darker. Genitalia as in

text-fig. 33, the limbs of the forceps with only a single segment, curved, sharply pointed, calliper-like; the penis with its two lobes fused to form a projecting, broadly rounded organ, flattened dorso-ventrally, dark brown basally, transparent distally and along both sides. Caudal filaments three, about equal, 9 mm. long, with about 40 long, slender cylindrical segments, followed at the extreme tips by a few very short, partly fused segments carrying long hairs.

FEMALE IMAGO, SUBIMAGO (both sexes), and NYMPH unknown.

Types.—Holotype male imago and series of six paratype male imagoes taken on the South Esk River at Clarendon, Tasmania, on 9th March, 1933, by Mr. Eric Scott, to whom the species is dedicated. Holotype mounted whole on slide in Canada Balsam; one paratype dissected and similarly mounted, the other five in spirit.

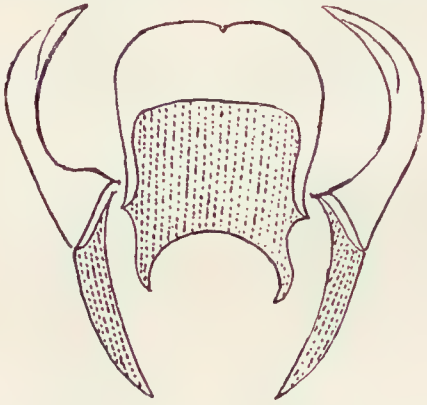


Fig. 33.—*Caenis scotti* n. sp. Male genitalia. (× 100.)

A very striking and distinctive species, easily recognized by the purple coloration of Sc and R_1 in forewing combined with the milk-white pterostigma, and by the tuft of long hairs at the end of each caudal filament. There is a similarly coloured, but much smaller, species in the mountains of Eastern Australia, not yet described.

SUMMARY

The paper forms Part II. of the 'Trout-food Insects of Tasmania,' and is intended to be read with Part I., in which *Atalophlebia australis* (Walker), the long-lost genotype of the genus *Atalophlebia*, was fully discussed and described. Part II. is a Monograph of the Mayflies of Tasmania, as far as at present known. A total of thirteen species is listed, of which no less than eight belong to the genus *Atalophlebia*. There are only four families represented, as follows:—Siphlonuridae (*Tasmanophlebia*, one species, previously

known); Leptophlebidae (eight species, all belonging to *Atalophlebia*, one known previously, seven new); Baëtidae *Baëtis*, one species, and *Cloëon*, one species, both new); Caenidae (*Tasmanocoenis*, one species, previously known, and *Caenis*, one species, new). The nymphs of seven of the species are known. The paper is illustrated with a plate showing ten forewings (imagoes and subimagoes), together with thirty-three text-figures.

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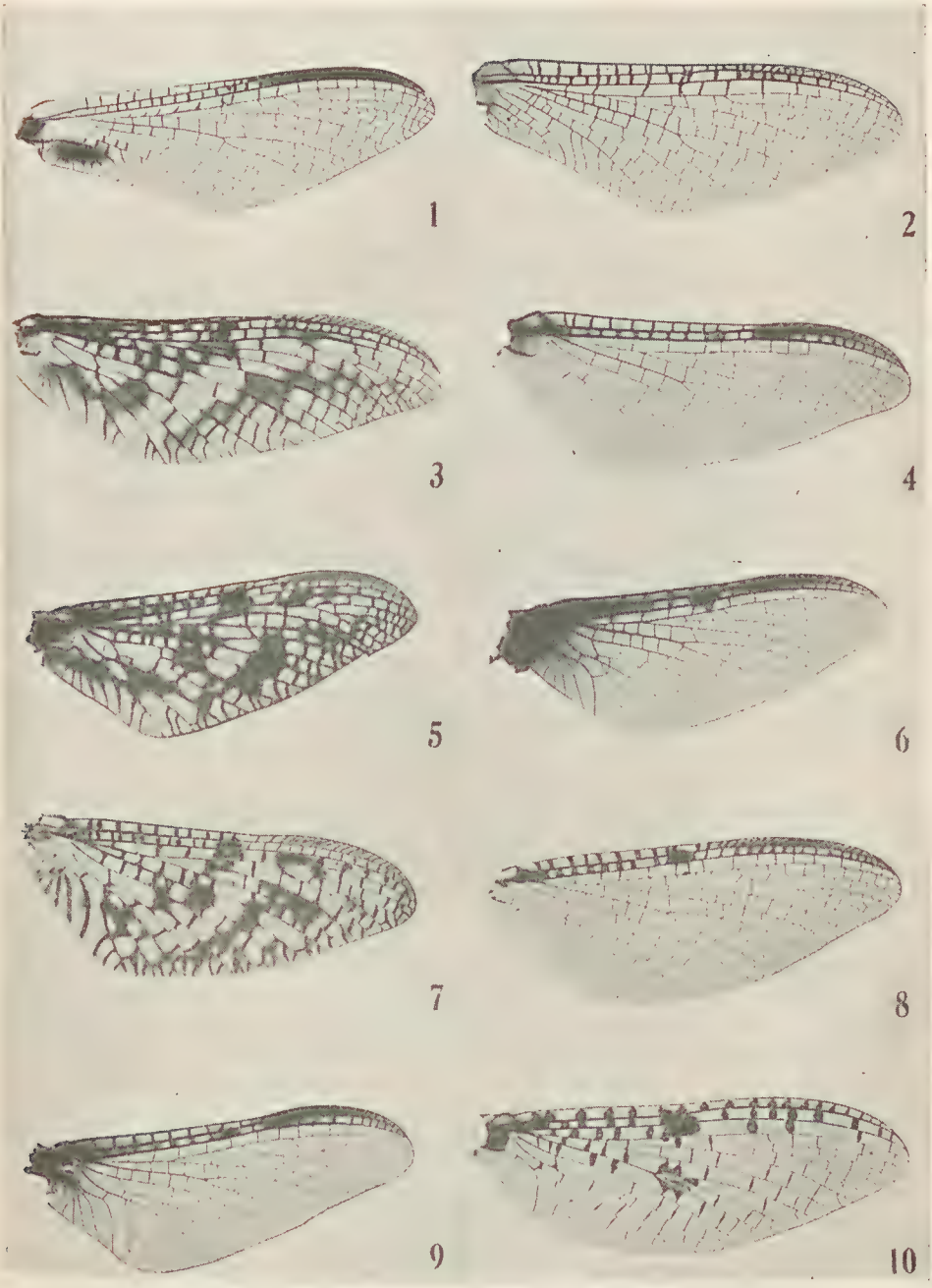
Explanation of Plate

PLATE I.—Photographic Enlargements of the Forewings in the Genera *Tasmanophlebia* (figs. 1, 2) and *Atalophlebia* (figs. 3-10):

Fig. 1. *Tasmanophlebia lacustris* Till. Male Imago.
Fig. 2. *Tasmanophlebia lacustris* Till. Female Imago.
Fig. 3. *Atalophlebia australis* (Walker). Subimago.
Fig. 4. *Atalophlebia australis* (Walker). Imago.
Fig. 5. *Atalophlebia superba* n. sp. Subimago.
Fig. 6. *Atalophlebia superba* n. sp. Imago.
Fig. 7. *Atalophlebia albiterminata* n. sp. Subimago.
Fig. 8. *Atalophlebia albiterminata* n. sp. Imago.
Fig. 9. *Atalophlebia hudsoni* n. sp. Imago.
Fig. 10. *Atalophlebia ida* n. sp. Imago.



Photographic Enlargements of the Forewings in the Genera *Tasmanophlebia* (figs. 1, 2) and *Atalophlebia* (figs. 3-10).

The Bythoscopidae of Australia (Homoptera, Jassoidea)

By

J. W. Evans, M.A., F.R.E.S.

Plates II-IV

In all works dealing with the classification of the Jassoidea, the Bythoscopidae are defined as leaf-hoppers that have their ocelli situated on the ventral surface of their heads and without a distinct margin between vertex and frons. A study of *Eurymela* Le P. and Serv. and related genera, supplied evidence that these genera, although comprised of insects that all have their ocelli ventrally placed, are not closely related to other Bythoscopid genera. Accordingly they have been placed in a separate family (Evans, 1934).

Whilst the Eurymelidae are a homogeneous group, that have as well as common structural characters, similar life-histories and habits, the Bythoscopidae appear to comprise a heterogeneous collection of genera, bound together by a common structural character, the ventral position of the ocelli. It is doubtful whether this character is of any great phylogenetic significance, or whether the majority of the genera are particularly closely related to each other. The presence or absence of a distinct margin between vertex and frons is a character of no value when applied to Australian forms. However, until more material is available, and further research concerned with both the morphology and habits of these insects carried out, it is convenient to retain the family as a unit.

In none of the taxonomic papers in which Australian leaf-hoppers have been described, that have appeared since 1907, has any attempt been made to revise Kirkaldy's classification, though all who have attempted to identify insects with the aid of his bulletins will agree that revision is needed.

This paper is one of a series dealing with the Australian Jassoidea. In each paper an attempt is being made to bring together all known Australian species that belong to the group under consideration. It is perhaps unfortunate that the Palaearctic Jassoid fauna was the first to be thoroughly studied, since the classification of other faunas has had of necessity to be based on this. If the Australian fauna had received similar attention in the past it is believed that a better understanding would now be had of the whole Jassoid complex.

Kirkaldy (1906), referring to the Australian region, pointed out that it demanded the attention of hemipterists, since it appeared to possess the oldest existing fauna in the world. His prediction that the classification of other faunas would have to be modified when the Australian fauna had been worked out, will doubtless prove correct.

Key to the Genera of Australian Bythoscopidae.

1. Head, including the eyes, wider than the pronotum at the base; bases of tegmina lying close behind the eyes 2

   Head, including the eyes, narrower than the pronotum at the base; bases of tegmina not lying close behind the eyes 8

2. Tegmen with a wide appendix 3

   Tegmen with a narrow or no appendix 4

3. Tegmen with sub-apical cells .... *Idiocerus* Lewis
   Type *Idiocerus adustus* Lewis

   Tegmen without sub-apical cells .... *Pediioscopus* Kirk.
   Type *Pediioscopus philenor* Kirk.

4. Ocelli nearer to the eyes on each side than to each other; or the distance between the ocelli equal to the distance between each ocellus and the adjacent eye 5

   Ocelli nearer to each other than to the eyes on each side .... *Austroagallia*, gen. nov.
   Type *Austroagallia torrida*, sp. nov.

5. Ventral surface of head more or less flat; maxillary plates narrow 6

   Ventral surface of head more or less in two planes; maxillary plates wide .... *Austroagalloides*, gen. nov.
   Type *Austroagalloides karoondae*, sp. nov.

6. Width of head equal to, or but little greater than, the length 7

   Head, including eyes, nearly twice as wide as long .... *Stenoscopus* Evans
   Type *Stenoscopus drummondi* Evans

7. Striations on pronotum transverse .... *Oncopsis* Burm.
   Type *Cicada flavicollis* L.

   Striations on pronotum oblique .... *Macropsis* Lewis
   Type *Cicada virescens* Lewis

8. Crown of head from above visible narrowly between the eyes; pronotum steeply declivous 9

   Crown of head from above visible widely between the eyes; pronotum not steeply declivous .... *Eurinoscopus* Kirk.
   Type *Eurinoscopus lentiginosus* Kirk.

9. Ventral surface of head evenly rounded *Chinaella*, gen. nov.
   Type *Chinaella argentata*, sp. nov.

   Ventral surface of head not evenly rounded, the clypeus lying almost at right-angles to the vertex .... *Trocnada* Walk.
   Type *Trocnada dorsigera* Walk.

In the majority of the descriptions of new species that follow, the colour pattern of the type is not given in great detail, since two individuals are seldom found that have identical markings. Instead numerous figures are given, in the hope that they will assist to render the descriptions intelligible.

Tribe MACROPSINI

This tribe is erected to hold the following genera: *Macropsis* Lewis, *Oncopsis* Burm., and *Stenoscopus* Evans. These genera, of which the last is represented by a single species occurring in Western Australia, are very similar to each other in general appearance and detailed structure.

Genus **Macropsis** Lewis

Trans. Ent. Soc. London 1 ; p. 49, 1835.

This genus is of world-wide distribution, and according to China (1925) contained in 1925 nearly seventy described species. Five species have been described previously from Australia: *abscondens* Walk. (*Bythoscopus*), (*Homopt. Ins. Suppl.*, p. 267, 1858); *oeroe* Kirk., *thymele* Kirk., *thyia* Kirk., and *thontias* Kirk. (*Bull. Hawaii. Sug. Ass. Ent.* 3; p. 36, 1909). Ten new species are described below. It is possible that a study of the food plants of *Macropsis* spp. would show that many of the species feed upon a single species of plant, since such an isolation would account for the many closely related forms that have developed. The figures render a redescription of this genus unnecessary. The presence of oblique striations on the pronotum is a character that enables its separation from *Oncopsis*, in which the striations are transverse. The male genitalia of all members of the Macropsini consist of long and narrow parameres and subgenital plates, that are frequently of almost equal length to each other, and an aedeagus of variable shape.

Macropsis occidentalis, sp. nov.

(Plate II, fig. 2)

Length, 4 mm. (from the apex of the head to the tip of the folded tegmina).

Head, width 1 mm., punctate, almost flat, with a slight median ridge on the vertex; hind margin produced dorsally; from above angularly produced, the crown (here considered as that part of the vertex as is visible from above) only visible at the sides against the eyes. Frons ochreous, the rest of the head greenish and ochreous, but for two diffuse black areas on the vertex; eyes reddish-brown.

Pronotum, punctate, pale greenish-brown, steeply declivous anteriorly, and higher in the middle than at the sides. *Scutellum*, smooth, yellowish; apex green. *Tegmen*, transparent, tinted slightly with yellowish-green; appendix small, barely perceptible.

Thorax and *abdomen*, ventral surface pale green. *Legs*, pale yellowish-green; tarsi, pale brown.

Type ♀, from Bruce Rock, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney.

Macropsis victoriensis, sp. nov.

(Plate II, figs. 1a, 1b, 1c)

Length, 4·5 mm. General coloration, greenish-yellow.

Head, width 1·2 mm., egg-yellow, eyes pale chocolate-brown; posterior margin of vertex angularly produced; crown from above visible for its entire width, wider against the eyes than in the middle.

Pronotum, olive-green, anterior lateral angles, yellow. *Scutellum*, yellow. *Tegmen*, clavus and costal margin, apple-green; costal area, colourless, transparent; apex, smoky grey.

Thorax and *abdomen*, ventral surface, yellowish. *Legs*, yellowish but for the hind tibiae, which are green.

Type ♂, from Burwood, Victoria (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Macropsis federalis, sp. nov.

(Plate II, fig. 3)

Length, 3·8 mm. General coloration, apple-green.

Head, width 1·2 mm., greenish-yellow, with two small brown markings below the ocelli; eyes reddish-brown, hind margin of head rounded; crown visible from above only as a narrow border against the eyes on each side.

Pronotum, pale green, the anterior margin angularly produced, so that in the centre it reaches beyond the posterior border of the head. *Scutellum*, yellowish-green, punctate. *Tegmen*, apple-green, but for the costal area and apex, which are colourless; appendix relatively wide.

Thorax, ventral surface yellow, with dark brown markings. *Legs*, pale yellow. *Abdomen*, ventral surface pale canary yellow.

Type ♀, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Macropsis filicis, sp. nov.

(Plate II, fig. 4)

Length, 3·2 mm. General coloration, yellowish-green.

Head, width 1 mm., lemon-yellow, ocelli brown, eyes chocolate-brown; crown from above visible as a band of even width between the eyes.

Pronotum, green, slightly declivous. *Scutellum*, yellow. *Tegmen*, yellowish-green, but for the apex, which is white.

Thorax and *abdomen*, ventral surface and *legs* very pale green.

Type ♀, from Fern Tree Gully, near Melbourne, Victoria (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Macropsis tasmaniensis, sp. nov.

(Plate II, fig. 5)

Length, 3 mm.

Head, width 1·2 mm., very pale yellowish-brown with dark brown punctures, and two very dark brown arcuate markings on the frons; eyes dark brown; crown from above visible as a wide border between the eyes, of equal width throughout.

Pronotum, almost flat; greyish-brown with dark brown punctures, and two dark brown oval markings against the anterior border, laterally. *Scutellum*, yellowish-brown with brown punctures. *Tegmen*, hyaline, clavus grey; veins brown, barred with white.

Thorax and *abdomen*, ventral surface dark brown. *Legs*, dark brown, but for the bases of the spines on the hind tibiae, which are black, and the first tarsal segment of the hind tibiae, which is very pale brown.

Type ♀, from the summit of Mount Wellington, Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Macropsis luteus, sp. nov.

(Plate II, fig. 6)

Length, 3·2 mm.

Head, width ·8 mm., somewhat convex; pale yellowish-brown with dark brown punctures, and two khaki coloured arcuate scars on the lateral borders of the frons; crown from above, visible as a wide band between the eyes, of equal width throughout.

Pronotum, pale yellowish-brown with brown punctures. *Scutellum*, anterior two-thirds, concolorous with the pronotum, the apical third smooth, pale yellowish-white. *Tegmen*, transparent, veins brown with white bars, appendix narrow.

Thorax, ventral surface, pale yellowish-white with black markings. *Legs*, pale yellowish-brown, but for the bases of the spines on the hind tibiae, which are black; spines strong. *Abdomen*, ventral surface, pale yellowish-brown.

Type ♀, from Bruce Rock, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney. This species has also been taken in the neighbourhood of Adelaide, South Australia.

Macropsis hobartensis, sp. nov.

(Plate II, fig. 7)

Length, 4 mm.

Head, width 1·2 mm., entirely ochreous; crown from above entirely visible, wider against the eyes than in the centre.

Pronotum, dull olive-green, the anterior lateral angles paler than the rest of the pronotum. *Scutellum,* yellow, with two brown triangular shaped markings against the anterior margin. *Tegmen,* transparent, veins colourless.

Thorax and *abdomen,* ventral surface, and *legs,* pale yellowish-brown.

Type ♀, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Macropsis lincolnensis, sp. nov.

(Plate II, fig. 8)

Length, 4 mm. General coloration, pale yellowish-brown.

Head, width 1·1 mm., pale biscuit colour with brown punctures and two oval ochreous markings just above the ocelli; eyes light brown; crown from above not visible in the centre.

Pronotum, light brown with dark brown spots, the anterior border smooth and yellow behind the eyes, the posterior two-thirds darker in colour; steeply declivous, so that the anterior margin is almost at right angles to the hind margin. *Scutellum,* ochreous, sparsely punctured with brown. *Tegmen,* clavus hyaline, grey, the rest of the tegmen colourless, transparent; anal veins buff, the other veins brown.

Thorax and *abdomen,* ventral surface, and *legs,* pale brown.

Type ♀, from Port Lincoln, South Australia (coll. A. M. Lea), in the collection of the South Australian Museum.

Macropsis flindersi, sp. nov.

(Plate II, fig. 9)

Length, 4·5 mm.

Head, width 1·5 mm., pale yellow and grey, with a few small scattered light brown spots and two brown oval markings just above the ocelli; eyes, pale brick red; crown of head from above visible only as a narrow border between the eyes.

Pronotum, declivous; grey flecked with brown spots, and two oval yellow areas against the anterior border laterally. *Scutellum,* egg-yellow, with a large black marking against the anterior border. *Tegmen,* transparent, suffused with very pale green, veins colourless.

Thorax and *abdomen,* ventral surface, and *legs,* pale yellow.

Type ♀, from Parachilna, Flinders Range, South Australia, in the collection of the South Australian Museum.

Macropsis wilsoni, sp. nov.

(Plate II, fig. 10)

Length, 4 mm.

Head, width 1·5 mm., pale brownish-yellow; eyes reddish-brown; crown of head from above visible narrowly against the eyes.

Pronotum, pale brown flecked with chestnut brown. *Scutellum*, yellow. *Tegmen*, yellowish-hyaline, the anal angle suffused with dark brown.

Thorax and *abdomen*, ventral surface, and *legs*, pale brown with dark brown markings.

Type ♀, from the Grampian Mountains, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Note.—A variety from Kiata is reddish-brown in colour.

Genus **Oncopsis** Burmeister

Gen. Ins. 1, 1838.

Insects in this genus can be distinguished from those in the previous genus by the character of the transverse striations on the pronotum. *Oncopsis*, like *Macropsis*, is of world-wide distribution. One species has previously been described from Australia: *balli* Kirk. (*Bull. Hawaii. Sug. Ass. Ent.* 3; p. 38, 1907).

Oncopsis scopulus, sp. nov.

(Plate II, fig. 13)

Length, 3 mm.

Head, width 1 mm., light and dark brown with dark brown punctures, the lateral arcuate markings on the frons, brown; crown from above wider against the eyes than in the centre.

Pronotum, only slightly declivous; the anterior border, medianly, and lateral angles, pale yellow; anterior half of pronotum dark brown, the posterior half dull grey, with ill-defined brown punctures. *Scutellum*, marked with a pattern of yellow and black. *Tegmen*, transparent, veins and apex of tegmen brown.

Thorax, ventral surface black. *Legs*, light and dark brown. *Abdomen*, ventral surface black, the hind border of each segment yellow; genital segments brown.

Type ♂, from Bruce Rock, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney.

Oncopsis pullus, sp. nov.

(Plate II, fig. 14)

Length, 5·5 mm.

Head, width 2 mm., pale brown with dark brown punctures, the arcuate markings, and a small oval area on each side above the

ocelli, ochreous; eyes dark brown; crown from above visible for its entire width, wider against the eyes than in the centre.

Pronotum, concolorous with the head, strongly declivous, so that the anterior margin is more or less at right angles to hind margin. *Scutellum*, pale yellowish-brown with dark brown punctures, the anterior lateral angles ochreous brown. *Tegmen*, transparent, suffused apically with very pale brown; veins pale brown.

Thorax, ventral surface, pale brown with dark brown markings; *Legs*, yellowish-brown, the bases of one row of spines on the hind tibiae dark-brown. *Abdomen*, ventral surface, yellowish-brown.

Type ♀, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the Australian Museum, Sydney. This species has also been taken at Hobart.

Oncopsis melleus, sp. nov.

(Plate II, fig. 15)

Length, 4·8 mm.

Head, width 1·5 mm., whitish-yellow with brown maculations; arcuate markings brown, edged with black, eyes red; crown from above not visible in the centre.

Pronotum, concolorous with the head. *Scutellum*, yellowish with black punctures, anterior lateral angles black. *Tegmen*, transparent, suffused with very pale brown, the apex and the veins dark-brown.

Thorax, ventral surface, dark brown. *Legs*, pale brown with dark brown markings. *Abdomen*, ventral surface, with each segment dark brown anteriorly and pale brown posteriorly; genital segments, dark brown.

Type ♂, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Oncopsis translucens, sp. nov.

(Plate II, figs. 11 a-e)

Length, 6 mm.

Head, width 1·8 mm., yellowish-white, with the arcuate markings brown, the rest of the frons dark brown; eyes pale brown; crown from above visible very narrowly in the middle, wide against the eyes.

Pronotum, declivous, with a slight median hump anteriorly; pale yellowish-white, punctate. *Scutellum*, yellow, with brown punctura-tions and irregular brown markings; anterior lateral angles, black. *Tegmen*, transparent, veins pale brown with white bars; appendix distinct.

Thorax, ventral surface, anteriorly pale yellowish, posteriorly black, each sclerite edged with yellow. *Legs*, light and dark brown.

Abdomen, ventral surface, pale yellowish; genital segments brown with yellow markings.

Type ♀, from Parachilna, Flinders Range, South Australia, in the collection of the South Australian Museum.

Oncopsis subfuscus, sp. nov.

(Plate II, figs. 12a, 12b)

Length, 5 mm.

Head, width 1·3 mm., whitish-yellow with dark brown punctures; eyes brown; crown from above not visible in the centre.

Pronotum, steeply declivous, the anterior border yellow; posteriorly grey with dark-brown punctures and maculations. *Scutellum*, yellow with black markings, the anterior lateral angles black. *Tegmen*, transparent, veins brown.

Thorax and *abdomen*, ventral surface, and *legs* marked with a pattern of light and dark-brown.

Type ♂, from Ooldea, South Australia (coll. A. M. Lea), in the collection of the South Australian Museum.

Oncopsis tepperi, sp. nov.

(Plate II, fig. 16)

Length, 5·2 mm.

Head, width 1·5 mm., pale reddish-brown with dark brown punctures; eyes dark brown; hind margin of head almost straight.

Pronotum, with light and dark brown markings, raised medianly into a distinct hump. *Scutellum*, yellowish-brown, the anterior lateral angles reddish-brown. *Tegmen*, brown, but for the costal margin, which is white, and the apex and clavus, which are mottled with very pale brown.

Thorax, ventral surface, dark brown. *Legs*, marked with a pattern of light and dark brown. *Abdomen*, ventral surface, pale brown.

Type ♀, from Kangaroo Island, South Australia (coll. J. G. Tepper), in the collection of the South Australian Museum.

Genus **Stenoscopus** Evans

Trans. Roy. Soc. South Australia 58; p. 166, 1934

This genus contains only one species (*drummondi* Evans), which has recently been described and figured.

Tribe AGALLIINI.

The insect described below has been compared with European and American species of *Agallia* Curtis, *Agalliopsis* Kirk., and *Aceratoagallia* Kirk., and found to differ in the shape of the head, distance between the ocelli, and dorsal thoracic segments. These differences are considered sufficiently striking to merit the erection of a new genus.

Austroagallia, gen. nov.

The head is longer than wide, and the labium reaches to between the hind legs. The ocelli, which are on the same plane as the clypeus, are sunk in depressions, and face outwards towards the eyes; they are closer to each other than to the eyes on each side. The crown is slightly produced anteriorly, and is of an even width throughout. The width of the pronotum is greater than its length, the anterior border is three-sided, and the posterior border straight. The scutellum is approximately half the length of the pronotum. The tegmina, which are steeply tectiform and have very narrow appendices, reach well beyond the end of the abdomen. The hind tibiae have four rows of long slender spines.

Austroagallia torrida, sp. nov. (Genotype)

(Plate III, figs. 1 a-e)

Length, 3·5 mm.

Head, width 1 mm., ivory with faint yellowish-brown markings; ocelli red, eyes black; crown with two large round black spots at the same distance from each other as from the eyes on each side.

Pronotum, ivory with yellowish-brown markings, and two black pear-shaped markings, lying behind those on the head. *Scutellum*, yellowish-brown. *Tegmen*, claval area, an opaque dirty-white, the rest of the tegmen transparent; veins brown, distinct.

Thorax, ventral surface, brown. *Legs*, pale yellow, the bases of larger spines brown. *Abdomen*, ventral surface, pale yellow.

Type ♂, from Adelaide, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney. Described from a long series of both sexes, all taken at light.

Austroagalloides, gen. nov.

In general appearance insects in this genus resemble *Idiocerus* spp. They differ, however, very widely in structure, and appear to be more closely related to *Agallia* spp., to which genus and other related genera they may be ancestral. Nothing is known of their life-history and habits beyond the fact that the majority of specimens taken have been beaten from trees of the genus *Eucalyptus*. The head lies in three distinct planes, so that the vertex bearing the ocelli and the hind margin of the frons, is more or less vertical and at right-angles to the anterior portion of the head. The ledges overhanging the antennae are pronounced, the clypeus usually extends beyond the maxillary plates, and the hind border of the frons is generally obscure. The eyes are large and prominent, so that the head, including the eyes, is wider than the pronotum at the base, and the crown from above, between the eyes, is broad and of even width throughout. The tegmina, which are long and

narrow, have either a very narrow appendix or no appendix at all, and the veins have raised dots, either lying alongside them or on the veins themselves. The hind tibiae usually have an armature of weak spines, seldom set on enlarged bases. The male genitalia have large pygophores, and parameres which are half the length of the sub-genital plates.

Austroagalloides karoondae, sp. nov. (Genotype)

(Plate III, fig. 6)

Length, 7·5 mm.

Head, width 2·5 mm., pale yellowish-brown suffused with pink; eyes reddish-brown; frons convex, ocelli large, situated at the apices of the lateral margins of the frons. *Pronotum*, grey, the anterior border pale yellowish-brown; the entire pronotum covered with raised transverse black markings. *Scutellum*, pale yellowish-brown, the apex pink and the anterior lateral angles brown; anteriorly a few brown maculations. *Tegmen*, transparent, grey, dotted with raised round brown spots that do not follow the course of the veins; veins pale yellow, appendix lacking.

Thorax and *abdomen*, ventral surface, and *legs*, pale yellowish-brown suffused with pink.

Type ♀, from Murat Bay, South Australia, in the collection of the South Australian Museum. A variety from Karoonda, South Australia, has the apices of the tegmina black.

Austroagalloides rosea, sp. nov.

(Plate III, figs. 4a, 4b)

Length, 8 mm.

Head, width 2·5 mm., pale yellow, eyes dark brown.

Pronotum, parchment colour, with transverse raised black markings on the posterior two-thirds. *Scutellum*, yellowish-brown, with two median black spots and two larger black markings lying against the anterior margin. *Tegmen*, hyaline, suffused with pink; veins pink, with small raised dots lying along both sides of every vein.

Thorax and *abdomen*, ventral surface, and *legs*, pale brownish-yellow.

Type ♀, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney. A pale yellow variety of this species has been taken at Launceston, Tasmania.

Austroagalloides grisea, sp. nov.

(Plate III, figs. 5a, 5b)

Length, 7 mm.

Head, width 2·2 mm., clypeus, maxillary plates, and lorae, white; frons pinkish-yellow; the vertical portion of the vertex pink, the dorsal part, or crown, yellowish.

Pronotum, pinkish-grey, anteriorly smooth; posteriorly with raised black transverse markings. *Scutellum*, grey, smooth. *Tegmen*, hyaline, veins and hind margin bright cherry-red; costal margin colourless; veins with raised spots incorporated in them and not lying at the sides; appendix small.

Thorax and *abdomen*, ventral surface, and *legs*, pale yellowish-white.

Type ♀, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Austroagalloides brunnea, sp. nov.

(Plate III, figs. 3a, 3b)

Length, 6·1 mm.

Head, width 2 mm., pale yellowish-brown, eyes grey. The vertex is not at right angles to the crown, and the ocelli, which are sunk in slight depressions, are visible from above. *Pronotum*, pale yellowish-brown. *Scutellum*, pale yellowish-brown, with two brown median spots and two large triangular brown markings against the anterior margin. *Tegmen*, yellowish-hyaline, veins yellow, with small raised dots on the actual veins; appendix very narrow.

Thorax and *abdomen*, ventral surface, and *legs*, pale brownish-yellow.

Type ♀, from Canberra, F.C.T. (coll. A. L. Tonnoir), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Austroagalloides agalliae, sp. nov.

(Plate III, figs. 2 a-d)

Length, 5·2 mm.

Head, width 1·5 mm., biscuit colour; eyes brown, the vertex with black markings that may extend on to the frons; antennal ridges oblique; ocelli facing outwards, the eyes sunk in slight depressions.

Pronotum, pale dirty yellow, with transverse raised black markings posteriorly and an irregular pattern of small black markings behind the eyes. The anterior border of the pronotum is sunk below the level of the hind margin of the head. *Scutellum*, smooth, pale yellowish. *Tegmen*, hyaline, veins pink with raised dots.

Thorax, ventral surface, black. *Legs*, whitish with light brown markings. *Abdomen*, ventral surface black, the posterior border of each segment yellow; genital segments brown.

Type ♂, from Canberra, F.C.T. (coll. A. L. Tonnoir), in the collection of the C.S.I.R. Division of Entomology at Canberra. This species has also been taken at Adelaide, South Australia.

Austroagalloides nigra, sp. nov.

(Plate III, fig. 7)

Length, 6·1 mm.

Head, width 1·5 mm., anteriorly up to the antennal ledges, yellow; vertex and crown black; eyes reddish-brown, ocelli yellow.

Pronotum, anteriorly yellow, with black maculations, posteriorly yellow suffused with black, and with raised transverse black markings. *Scutellum*, smooth, black. *Tegmen*, yellowish-hyaline, black apically; veins black with raised dots.

Thorax and *abdomen*, ventral surface, and *legs*, yellow.

Type ♂, from Leura, New South Wales, in the collection of the Australian Museum, Sydney. A paler variety has been taken at Hobart, Tasmania.

Austroagalloides wrighti, sp. nov.

(Plate III, figs. 8a, 8b)

This species is larger and broader than the preceding ones, but in essential characters resembles other species in the genus.

Length, 7 mm.

Head, width 3·5 mm., anteriorly pale yellowish-brown, but for the frons, which is a somewhat darker brown; vertex and crown marked with an irregular pattern of yellow and black; eyes dark brown; frons swollen; ocelli facing towards the eyes; hind margin of frons distinct; eyes very prominent.

Pronotum, anteriorly brownish-yellow with irregular black markings, posteriorly grey with raised transverse black markings. *Scutellum*, rugose, marked with a pattern of light and dark brown. *Tegmen*, hyaline, with numerous cross veins and round brown spots lying alongside the main veins; appendix narrow.

Thorax and *abdomen*, ventral surface, brown. *Legs*, marked with a pattern of light and dark brown.

Type ♀, from Karoonda, South Australia (coll. G. Wright), in the collection of the South Australian Museum.

Tribe BYTHOSCOPINI

Three genera which have several common characteristics are placed together in this tribe. The head, including the eyes, is narrower than the pronotum at the base. The pronotum is wide laterally, so that the bases of the tegmina are separated from the eyes, and the propleurae which extend laterally from the pronotum are also wide. The tegmina have a somewhat narrow appendix, and the

apical cubital cell serves as a supplementary appendix, the vein bounding its dorsal margin being more heavily chitinised than that bounding the tegmen within the true appendix. The hind tibiae are somewhat flattened, and bear three rows of strong spines and one row of long delicate spines. The apices of the hind femora rest just behind the eyes.

Genus **Bythoscopus** Germar

Rev. Ent. 1; p. 180, 1833.

Numerous Australian leaf-hoppers were placed in this genus by Walker. None of them is congeric with the genotype, *Bythoscopus lanio* L.

Genus **Eurinscopus** Kirkaldy

H.S.P.A. Exp. Sta. Bull. 1 (9); p. 346, 1906

Kirkaldy considered this genus to be the Australian representative of *Bythoscopus* Germ., differing from the latter in the venation of the tegmen. An examination of the paratypes of the seven species he described has shown that two of his names are synonyms. The following species were described by Kirkaldy; *lentiginosus* (genotype), *sontiates, soboles, molestia, dryas, pelias,* and *pelamys. E. pelias* and *E. pelamys* are synonymous with *E. dryas* Distant (1908) refused to recognize Kirkaldy's genus, and described an insect from Australia which he placed in the genus *Bythoscopus.* This species, *viridipes,* undoubtedly belongs to the genus *Eurinoscopus.*

Eurinoscopus differs from *Bythoscopus* in the absence of numerous costal cells in the tegmen, and the greater length of the tegmen in comparison with its breadth. In addition the pygophores of the male genitalia of *Eurinoscopus* do not extend ventrally so as to cover the parameres and sub-genital plates as they do in *Bythoscopus.* ... In spite of these differences and the fact that insects in the genus *Eurinoscopus* are smaller and slenderer than *B. lanio,* the two genera are undoubtedly very closely related. Figures (Plate IV, figs. 1a, 1b) are given of the tegmen and the head in profile of *Bythoscopus lanio.* A redescription of *Eurinoscopus* Kirk. is given below.

Head with the labium reaching to between the middle pair of legs, and the lorae anteriorly not reaching to the front margin of the maxillary plates. The frons is evenly rounded, the antennal ridges lying halfway up the lateral margins. The ocelli are large, lie well away from the frons, and are closer to the eyes on each side than to each other. The hind border of the head, as seen from below, is evenly rounded, while the crown of the head from above is of even

width throughout. The eyes are not prominent, so that the head, including the eyes, is slightly narrower than the pronotum at its base. The anterior margin of the pronotum is evenly rounded and parallel to the fore (dorsal) border of the head, the lateral margins are almost parallel to each other, and the hind margin is straight. Both the head and pronotum are transversely striated. The scutellum is equal in length to the pronotum, and the apex is slightly raised. The propleurae continue laterally from the pronotum, the bases of the tegmina being widely separated from the eyes. The tegmina are long and narrow, and overlap posteriorly, the ventral apical cell forming a supplementary appendix. The veins are bordered on each side by a row of small punctures. The hind tibiae are somewhat flattened, and bear two rows of long strong spines, one row of strong short spines, and one row of delicate spines or hairs. The male genitalia resemble those of *Austroagalloides* in the development of the pygophores, and such genera as *Macropsis* in the possession of long and narrow parameres and sub-genital plates.

Eurinoscopus viridis, sp. nov.

(Plate IV, fig. 5)

Length, 5 mm.

Head, width 1·5 mm., emerald green, but for the frons and ocelli, which are yellowish; eyes dark brown.

Pronotum, emerald green. *Scutellum*, emerald green, lateral angles and apex yellow. *Tegmen*, transparent, suffused with pale yellowish-green.

Thorax and *abdomen*, ventral surface, and *legs*, pale yellowish-green.

Type ♂, from Adelaide, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney. A variety from Canberra is pale brownish-yellow in colour and has red eyes.

Eurinoscopus pallidus, sp. nov.

(Plate IV, figs. 3a, 3b)

Length, 4·5 mm.

Head, width 1·8 mm., pale brownish-yellow.

Pronotum and *scutellum*, pale brownish-yellow.

Thorax and *abdomen*, ventral surface, and *legs*, very pale brownish-yellow.

Type ♀, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Eurinoscopus elegans, sp. nov.

(Plate IV, figs. 2 a.-b)

Length, 5·5 mm.

Head, width, 1·8 mm., pale chestnut brown, dark brown between the ocelli; ocelli colourless, eyes pale chocolate-brown.

Pronotum, pale brownish-yellow, with orange-brown markings. *Scutellum*, brownish-yellow, the anterior lateral angles orange-brown. *Tegmen*, hyaline, yellowish-green.

Thorax and *abdomen*, ventral surface, pale brownish-yellow. *Legs*, brown.

Type ♂, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Eurinoscopus citrinus, sp. nov.

(Plate IV, fig. 4)

Length, 6·2 mm.

Head, width 1·8 mm., pale lemon-yellow, dorsal margin of frons above antennal ledges distinct.

Pronotum and *scutellum*, pale lemon-yellow. *Tegmen*, yellowish-hyaline, rugose, with a few brown spots on the veins and no cross veins.

Thorax and *abdomen*, ventral surface, and *legs*, pale lemon-yellow.

Type ♀, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Chinaella, gen. nov.

The head is evenly rounded, the antennal ledges are prominent, the hind margin of the frons is distinct, and the ocelli are on the ventral surface of the head. The crown is visible narrowly from above, being widest against the eyes, and the head, including the eyes, is narrower than the pronotum at the base. The lateral margins of the pronotum are narrow in comparison with species in related genera, but sufficiently wide to separate the bases of the tegmina from the eyes, and the propleurae are visible as lateral prolongations of the pronotum. The tegmina overlap very considerably, so that when the tegmina are closed the distal parts of the anal borders lie at an acute angle to the proximal conjoined borders. The appendix is wide, and there is a supplementary appendix. Insects in this genus, whilst resembling *Eurinoscopus* spp. in the shape of the head and the position of the ocelli, are more similar in general appearance to *Trocnada* spp.

Chinaella argentata, sp. nov. (Genotype)

(Plate IV, fig. 6)

Length, 4·5 mm.

Head, width 2 mm., cream colour mottled with pale reddish-brown.

Pronotum, steeply declivous, golden-yellow flecked with brown. *Scutellum*, reddish-yellow. *Tegmen*, proximally brownish-yellow, distally yellowish-white; veins brown, venation reticulate.

Thorax, ventral surface, and *legs*, pale brown. *Abdomen*, ventral surface, white suffused with very pale brown; genital segments brown.

Type ♀, from the Everard Ranges, South Australia (coll. A. Brumby), in the collection of the South Australian Museum.

Chinaella shephardi, sp. nov.

Length, 4 mm.

Head, width 1·8 mm., frons and vertex reddish-brown mottled with yellow, clypeus, lorae, and maxillary plates black; eyes grey.

Pronotum, reddish-brown, slightly declivous. *Scutellum*, yellowish-brown with dark brown markings. *Tegmen*, reddish-brown with a white streak along the costal margin and a purplish-brown stripe lying along the claval suture; veins brown apically.

Thorax, ventral surface, and *legs*, dark brown. *Abdomen*, ventral surface, pale brown.

Type ♀, from Broken Hill, New South Wales (coll. F. W. Shephard), in the collection of the South Australian Museum.
sp. nov.

Chinaella cudmorei, sp. nov.

(Plate IV, fig. 7)

Length, 4 mm.

Head, width 1·5 mm., anteriorly and frons, ochreous; vertex, pale brownish-yellow.

Pronotum, ochreous. *Scutellum*, dark reddish-brown, apically pale brown. *Tegmen*, hyaline, mottled with pale brown; veins pale brown, venation not reticulate.

Thorax and *abdomen*, ventral surface, and *legs*, pale brown.

Type ♂, from 130 miles S.E. of Broome, Western Australia (coll. A. S. Cudmore), in the collection of the Australian Museum, Sydney.

Genus **Trocnada** Walker

Ins. Saund. Homopt. 104, 1858

The head lies in two distinct planes of approximately equal length, the anterior portion up to the antennal ledges is parallel to the long axis of the body, and the posterior portion, on which is situated the hind margin of the frons and the ocelli, is vertical and at right-angles to the axis of the body. The antennal ledges are curved,

and project beyond the surface of the head. The pronotum, which is transversely striated, is very steeply declivous, and at the base is wider than the head. It is wide laterally, and the propleurae are visible, and separate the eyes from the bases of the tegmina. The tegmina have, in addition to a wide appendix, a supplementary appendix formed from the apical cubital cell; this cell is not pigmented. The apices of the hind femora rest just behind the eyes, and the hind tibiae, which are somewhat flattened, bear four rows of spines.

One species has previously been placed in this genus, *Trocnada dorsigera* Walker. *Albelterus incarnatus* Stål (*Öfv. Vet-Ak. Förh.* 22; p. 1, 1865) is synonymous with *T. dorsigera*.

Trocnada gigantea, sp. nov.

(Plate IV, figs. 8a, 8b)

Length, 8·2 mm.

Head, width 3 mm., pale biscuit colour suffused with pink; ocelli colourless or red, eyes red.

Pronotum, pale biscuit colour, in some specimens suffused with pink. *Scutellum*, yellowish-pink. *Tegmen*, pink.

Thorax, ventral surface, and *legs*, biscuit colour partly suffused with pink. *Abdomen*, ventral surface, pale biscuit colour.

Type ♀, from Karoonda, South Australia, in the collection of the South Australian Museum.

Trocnada minuta, sp. nov.

(Plate IV, fig. 9)

Length, 4·5 mm.

Head, width 1·8 mm., ochreous, ocelli pink.

Pronotum, reddish-brown. *Scutellum*, dark brown. *Tegmen*, hyaline brown, veins pinkish-brown.

Thorax and *abdomen*, ventral surface, and *legs*, ochreous brown.

Type ♂, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Tribe IDIOCERINI

This tribe contains two Australian genera. Of tnese, *Idiocerus* Lewis is of world-wide distribution, whilst *Pedioscopus* Kirk. is confined to Australia. Insects in these genera resemble *Austroagalloides* spp. in general appearance, but differ in the shape of the head, the venation of the tegmina, the presence of a broad appendix, the armature of the hind tibiae, and the structure of the male genitalia.

Genus **Idiocerus** Lewis

Trans. Ent. Soc. London 1; p. 47, 1835

Fourteen species have previously been described from Australia: *cupreus* Walk. (*Bythoscopus*), (List Homopt. 111; 871, 1851); *ipo* Kirk. (*Bull. Hawaii. Sug. Ass. Ent.* 1 (9); 466, 1906), and *kisseis* Kirk., *oreias* Kirk., *orodemnias* Kirk., *zantho* Kirk., *hyleorais* Kirk., *cupido* Kirk., *napais* Kirk., *aulonias* Kirk., and *nereias* Kirk., (*H.S.P.A. Bull.* 3; pp. 32-4, 1907); *geoffroyi* Dist. (*Ann. Soc. Ent. Belg.* 52; 99, 1908); *leurensis* Evans (*Trans. Roy. Soc. South Austr.* 58; p. 167, 1934).

A redescription of this genus has been published recently, so it will be sufficient to give here such characters as will serve to distinguish it from other genera described in this paper.

The head is slightly convex, and the ocelli lie more or less on the same plane as the clypeus. The dorsal margin of the frons is not distinct, and the ocelli appear to lie at the apices of the lateral margins of the frons. The eyes are large, and the crown of the head from above is broad and of equal breadth throughout, and the head, including the eyes, is wider than the pronotum at its base. The tegmina have very broad appendices, and there are never more than two sub-apical cells between the radius and the cubitus. The subgenital plates of the male are usually long and narrow and the parameres short.

Idiocerus kirkaldyi, sp. nov.

(Plate IV, figs. 9b, 10b)

Length, 6·8 mm.

Head, width 2 mm., yellow suffused with pink, with two round black markings on the vertex close to the eyes; eyes chocolate-brown; clypeus wider anteriorly than at the base, frons almost flat.

Pronotum, yellow suffused with pink, with two black markings behind the eyes and close to the posterior border. *Scutellum*, marked with a pattern of black and pinkish-yellow. *Tegmen*, transparent, grey apically; veins pink, costal margin black.

Thorax and *abdomen*, ventral surface, pale yellow. *Legs*, marked with a pattern of pink, yellow, and brown.

Type♀, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Idiocerus seckeri, sp. nov.

Length, 5·5 mm.

Head, width 2 mm., pale pinkish-yellow.

Pronotum, concolorous with the head. *Scutellum*, pinkish-brown. *Tegmen*, brown, hyaline, with two transparent white fasciae; costal margin between the fasciae, reddish-brown; veins pink.

Thorax, ventral surface, white with black markings. *Legs*, very pale yellow. *Abdomen*, ventral surface, black, each segment white posteriorly.

Type ♂, from Lucindale, South Australia (coll. F. Secker), in the collection of the South Australian Museum.

Idiocerus inconsequens, sp. nov.

Length, 4·5 mm.

Head, width 1·2 mm., yellowish-green, eyes dark-brown, frons flat.

Pronotum and *scutellum*, yellowish-green. *Tegmen*, hyaline, yellowish-green.

Thorax and *abdomen*, ventral surface, and *legs*, yellowish-green; abdomen not nearly reaching posteriorly to the apex of the folded tegmina.

Type♀, from Emerald, Victoria (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Idiocerus divisus, sp. nov.

(Plate IV, fig. 19)

Length, 4 mm.

Head, width 1·2 mm., yellowish-pink, eyes dark brown, frons swollen.

Pronotum and *scutellum*, yellowish-pink. *Tegmen*, hyaline, yellowish-pink.

Thorax and *abdomen*, ventral surface, and *legs*, yellowish-pink; posterior margin of the last ventral abdominal segment in the female divided medianly.

Type♀, from Bruce Rock, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney.

Idiocerus lesmurdiensis, sp. nov.

Length, 3 mm.

Head, width 1 mm., bright yellow, with a large oval pink area on the vertex.

Pronotum and *scutellum*, yellow. *Tegmen*, transparent, suffused with pale green; proximal costal margin white.

Thorax and *abdomen*, ventral surface, and *legs*, yellow; posterior margin of the last ventral abdominal segment in the female, straight; apex of abdomen nearly reaching to the tip of the folded tegmina.

Type ♀, from Lesmurdie, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney.

Genus **Pedioscopus** Kirkaldy

H.S.P.A. Exp. Sta. Bull. 1 (9) ; p. 349, 1906

This genus, which comprises insects closely allied to *Idiocerus*, is apparently confined to Australia. The figures of *P. polydoros* Kirk. (Plate IV, 12, 12a, 12b) were drawn from the paratype. The venation is unusual, the median vein being distinct, and not fused basally with the radius. Kirkaldy described the following species: *philenor*, *polydoros*, and *agenor*. *P. agenor* is a synonym of *P. polydoros*.

Conclusion

It is hoped that when this series of papers is completed it will be possible to present a summary, giving a key to the families, subfamilies, tribes, and genera dealt with, and at the same time to indicate the various evolutionary trends within the groups concerned. The present need is more material for study, since leaf-hoppers are usually passed over by collectors, and the material now available in Australian museums can represent only a very small proportion of the available fauna. Kirkaldy (1906), in commenting on the rich fauna of leaf-hoppers that must occur in Australia, pointed out that Koebele and Perkins collected for only a few months in the very places that an entomologist, not collecting for an economic purpose, would avoid on account of their barrenness. Yet their efforts produced nearly five hundred new species. The collection named by Kirkaldy was taken almost entirely in Queensland and the coastal districts of New South Wales. The bulk of the material that has been available to the present author was collected on the mountains and tablelands of New South Wales and in South Australia. The most interesting Jassoid fauna occurs in Western Australia, a region in which systematic collecting has never been undertaken.

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The systematist who is out of touch with libraries and museums is to a great extent dependent on those more fortunately placed if he is to make any real progress, and not merely to add to the confusion already existing. In this study of the Australian Jassoidea, I have been in constant correspondence with Mr. W. E. China, of the British Museum, who has never failed to assist me, and without whose aid this series of papers could never have been written. I am also indebted to Dr. O. H. Swezey, of Honolulu, for the loan of seventy-four of Kirkaldy's paratypes; to Professor H. B. Hungerford, for the gift of a large collection of named American Jassoidea, which have been invaluable for comparative purposes; and to the authorities in charge of the South Australian Museum, for permitting me to examine the collection in their care.

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Explanation of Plates

Plate II—

Fig. 1a.—*Macropsis victoriensis*, head, ventral aspect.
Fig. 1b.—*Macropsis victoriensis*, head and thorax, dorsal aspect.
Fig. 1c.—*Macropsis victoriensis*, tegmen.
Fig. 2.—*Macropsis occidentalis*, head and thorax, dorsal aspect.
Fig. 3.—*Macropsis federalis*, head and thorax, dorsal aspect.
Fig. 4.—*Macropsis filicis*, head and thorax, dorsal aspect.
Fig. 5.—*Macropsis tasmaniensis*, head and thorax, dorsal aspect.
Fig. 6.—*Macropsis luteus*, head and thorax, dorsal aspect.
Fig. 7.—*Macropsis hobartensis*, head and thorax, dorsal aspect.
Fig. 8.—*Macropsis lincolnensis*, head and thorax, dorsal aspect.
Fig. 9.—*Macropsis flindersi*, head and thorax, dorsal aspect.
Fig. 10.—*Macropsis wilsoni*, head and thorax, dorsal aspect.
Fig. 11a.—*Oncopsis translucens.*
Fig. 11b.—*Oncopsis translucens*, head, ventral aspect.
Fig. 11c.—*Oncopsis translucens*, head and thorax, dorsal aspect.
Fig. 11d.—*Oncopsis translucens*, tegmen.
Fig. 11e.—*Oncopsis translucens*, hind tibia.
Fig. 12a.—*Oncopsis subfuscus*, tegmen.
Fig. 12b.—*Oncopsis subfuscus*, head and thorax, dorsal aspect.
Fig. 13.—*Oncopsis scopulus*, head and thorax, dorsal aspect.
Fig. 14.—*Oncopsis pullus*, head and thorax, dorsal aspect.
Fig. 15.—*Oncopsis melleus*, head and thorax, dorsal aspect.
Fig. 16.—*Oncopsis tepperi*, head and thorax in profile.

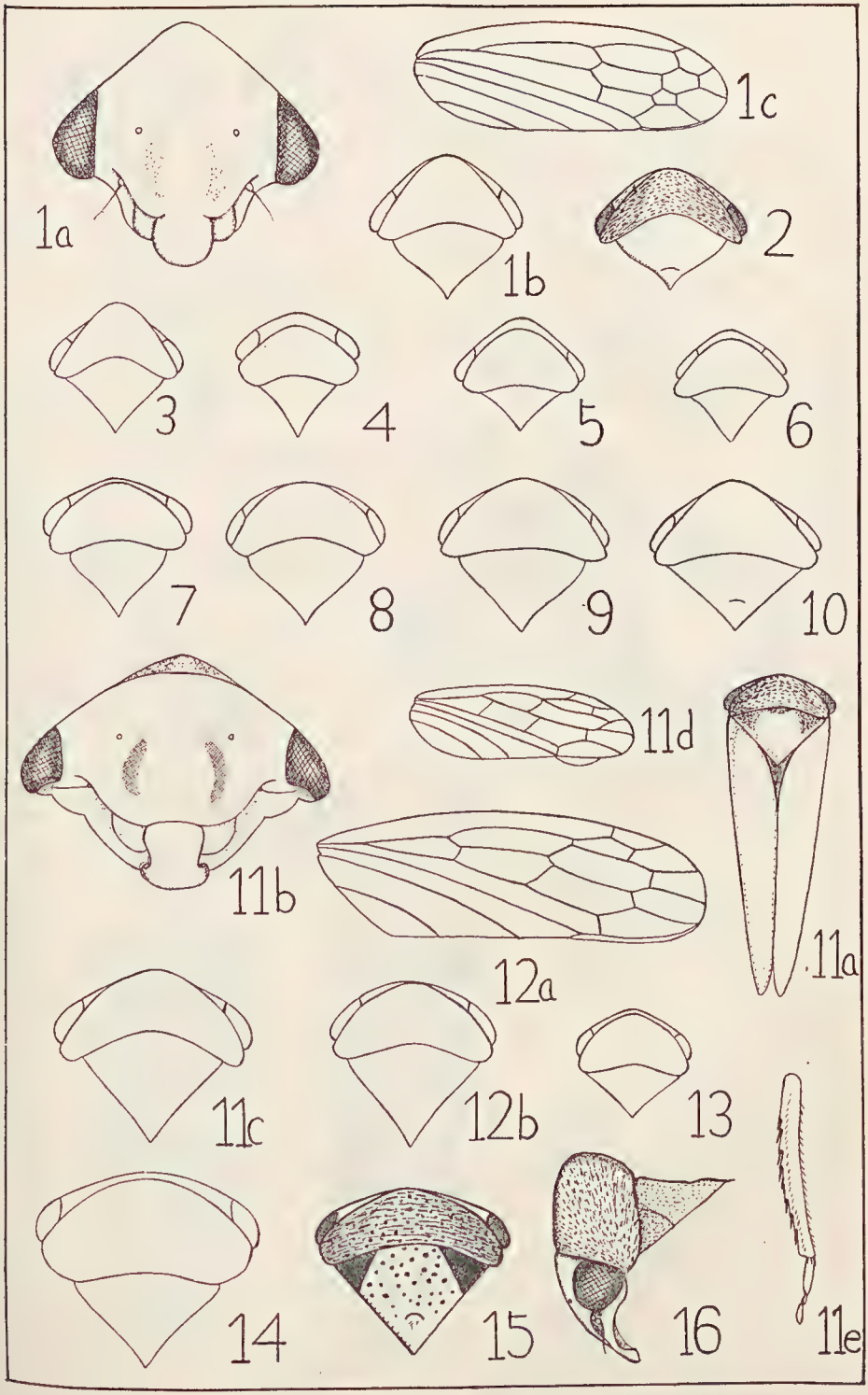
Plate III—

Fig. 1a.—*Austroagallia torrida*, tegmen.
Fig. 1b.—*Austroagallia torrida*, head, ventral aspect.
Fig. 1c.—*Austroagallia torrida*, head and thorax, dorsal aspect.
Fig. 1d.—*Austroagallia torrida*, hind tibia.
Fig. 1e.—*Austroagallia torrida*, male genitalia.
Fig. 2a.—*Austroagalloides agalliae*, tegmen.
Fig. 2b.—*Austroagalloides agalliae*, head, ventral aspect.
Fig. 2c.—*Austroagalloides agalliae*, head and pronotum, dorsal aspect.
Fig. 2d.—*Austroagalloides agalliae*, male genitalia.
Fig. 3a.—*Austroagalloides brunnea*, head, ventral aspect.
Fig. 3b.—*Austroagalloides brunnea*, head and pronotum, dorsal aspect.
Fig. 4a.—*Austroagalloides rosea*, tegmen.
Fig. 4b.—*Austroagalloides rosea*, head and pronotum, dorsal aspect.
Fig. 5a.—*Austroagalloides grisea*, head and pronotum, dorsal aspect.
Fig. 5b.—*Austroagalloides grisea*, hind tibia.
Fig. 6.—*Austroagalloides karoondae*, head and pronotum, dorsal aspect.
Fig. 7.—*Austroagalloides nigra*, head and pronotum, dorsal aspect.
Fig. 8a.—*Austroagalloides wrighti*, dorsal aspect.
Fig. 8b.—*Austroagalloides wrighti*, ventral aspect.

Plate IV—

Fig. 1a.—*Bythoscopus lanio*, tegmen.
Fig. 1b.—*Bythoscopus lanio*, head in profile.
Fig. 2a.—*Eurinoscopus elegans.*

Fig. 2b.—*Eurinoscopus elegans*, tegmen.
Fig. 2c.—*Eurinoscopus elegans*, head and thorax in profile.
Fig. 2d.—*Eurinoscopus elegans*, head, ventral aspect.
Fig. 2e.—*Eurinoscopus elegans*, head and thorax, dorsal aspect.
Fig. 2f.—*Eurinoscopus elegans*, male genitalia.
Fig. 3a.—*Eurinoscopus pallidus*, head and thorax, dorsal aspect.
Fig. 3b.—*Eurinoscopus pallidus*, hind leg.
Fig. 4.—*Eurinoscopus citrinus*, head and thorax, dorsal aspect.
Fig. 5.—*Eurinoscopus viridis*, head and thorax, dorsal aspect.
Fig. 6.—*Chinaella argentata*.
Fig. 7.—*Chinaella cudmorei*, male genitalia.
Fig. 8a.—*Trocnada gigantea*, head and thorax in profile.
Fig. 8b.—*Trocnada gigantea*, hind tibia.
Fig. 9.—*Trocnada minuta*, head and pronotum, anterior aspect.
Fig. 9b.—*Idiocerus kirkaldyi*.
Fig. 10b.—*Idiocerus kirkaldyi*, hind tibia.
Fig. 11.—*Idiocerus divisus*, head, ventral aspect.
Fig. 12.—*Pedioscopus polydoros*, head, ventral aspect.
Fig. 12a.—*Pedioscopus polydoros*.
Fig. 12b.—*Pedioscopus polydoros*, tegmen.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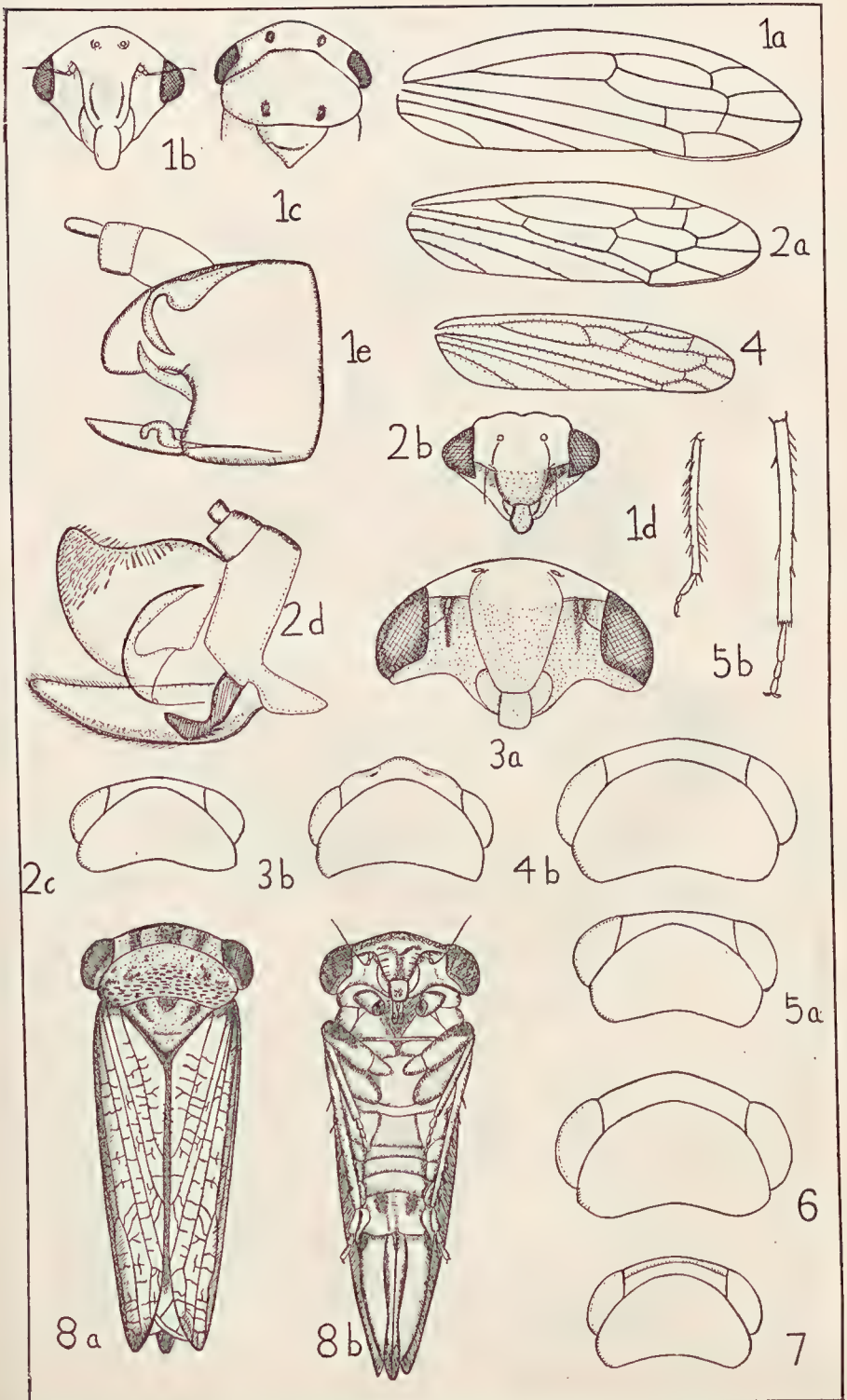
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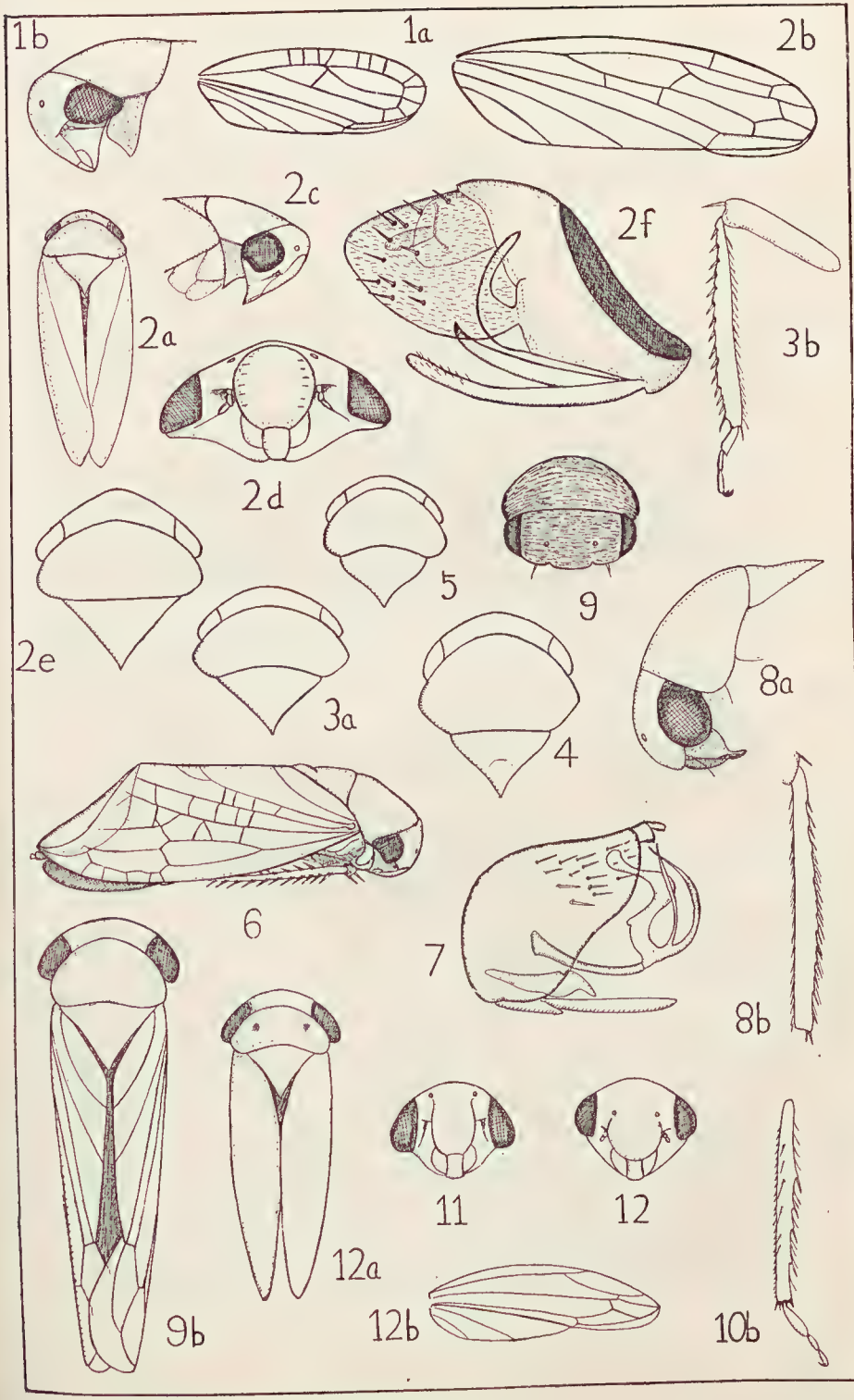
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Observations on Fishes of the Family Galaxiidae

Part I

By

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(Read 30th September, 1935)

In addition to their general importance as members of a remarkable family, the Tasmanian Galaxiidae are of special interest for several reasons. First, there are, as shown below, good grounds for believing that the island provides the type-locality of the genotype of the foundation-genus; secondly, the early observations of Johnston in Tasmania rank in historic interest with those of Hutton and Clarke in New Zealand; thirdly, the diversity of the Tasmanian Galaxiid fauna, it is now becoming apparent, rivals that of New Zealand, traditionally regarded as the headquarters of the family.

The primary object of the present paper is the description of four new species, one of which is referred to a new genus, *Saxilaga*, an interesting annectant form linking *Galaxias* Cuvier and *Neochanna* Günther.

Previously described Tasmanian species are listed, and in several cases commented upon: a detailed consideration of them is reserved, however, for a subsequent communication.

Since the revision by Regan, some thirty years ago, the family has considerably increased in number and diversity of forms, and it is apparent the time has arrived when some redistribution of its members is called for. In a recent paper Whitley (1935) has expressed the opinion that *Galaxias indicus* Day,[1] from littoral districts of Bengal and Madras, is 'only superficially like a *Galaxias*, and belongs to some other genus not yet determined', and has suggested the new generic names *Nesogalaxias*, *Lyragalaxias*, and *Querigalaxias*, for *Galaxias neocaledonicus* Weber and De Beaufort (New Caledonia), *Galaxias o'connori* Ogilby (Queensland), and *Galaxias dissimilis* Regan (? New South Wales), respectively. As these proposed names are not yet validated by the provision, in

[1] This species, which is not noted by Regan (1906) in his revision, is described (1888, p. 806) as having 'fine conical' teeth 'in the lower jaw, vomer and palatines, and some larger ones on the tongue'; the pelvics are eight-rayed.

accordance with the Code, of a summary of characters, it seems advisable, in order both not to anticipate Mr. Whitley's conclusions and to avoid any possibility of nomenclatural confusion, to leave the species concerned for the present in the position in which they now stand. *Galaxias bullocki* Regan, for which the genus *Brachygalaxias* has been proposed, I would at present be inclined to refer to a subgenus of *Galaxias*, occupying the position tentatively shown in brackets in the accompanying key, rather than to a separate genus: it is possible, however, that the two main characters noted by Regan (1908) as distinguishing it from all other species, namely, the presence of only five rays in the pelvic, and the insertion of the anal partly in advance of the dorsal, may prove, upon further consideration, to be worthy, when regarded in combination, of generic recognition. The resuscitation by Whitley of Ogilby's genus *Austrocobitis* for *Galaxias attenuatus* (Jenyns) has not been followed here, again in view of the absence of the diagnosis needed for the satisfactory delimitation of the genus.

The suggestions in regard to classification put forward in the present communication are governed by the desire, first, to supply such elements of the scaffolding of the taxonomic frame of reference as seem at once well-founded and expedient for the convenient handling of the material here dealt with, and, secondly, to avoid taking, at the present stage of the inquiry, any steps likely in any way to prejudice the complete revision of the systematics of the family that is undoubtedly desirable, but for which adequate data are perhaps not yet available.

The present taxonomic proposals comprise the institution of two new subfamilies, a new genus, with two subgenera, and two new subgenera of *Galaxias*. The primary feature on which the subfamilies are based is the general location of the dorsal, whether above the anal or the pelvic; to which may be added in part the uniserial or biserial arrangement of the premaxillary and mandibulary teeth, and the number of vertebrae. Characters regarded as of generic importance are the presence or absence of teeth on the palate, and the presence or absence of pelvic fins; while the number of rays in the pelvic is accorded subgeneric recognition. In the forms with a posteriorly placed dorsal the exact point of origin of the fin in relation to the anal, while affording a superficially attractive, if confessedly somewhat artificial, subgeneric criterion, is not made use of here for, among others, the following reasons: first, it exhibits some individual variation; secondly, its employment would involve, on the one hand, the association of species (*e.g., G. (G.) attenuatus* and *G. (G.) scopus*) that, judged by other standards, are obviously far from being closely allied, and, on the other hand, the separation of species (*e.g., G. (G.) auratus* and *G. (G.) scopus*) clearly belonging to the same group.

In retaining *Paragalaxias shannonensis* (and possibly also *G. dissimilis* Regan) in the Galaxiidae a conservative course has been followed. It may be observed that Regan (1913, p. 289) has pointed out, and has since (1914, p. 405) emphasized the importance of, the fact that of the salmonoid fishes, *sensu lato*, the Salmonidae alone have the vertebrae upturned at the base of the caudal fin. A comparison of *P. shannonensis* (all examples of which hitherto secured are small, the largest, the holotype, having a total length of 40·7 mm.), *G. attenuatus*, and *Salmo irideus* Gibbons seems to show that, morphologically, no sharp line of demarcation can be drawn between them. The practical value of the criterion, which lies principally in the circumstance that the upturned centra in the representative of the Salmonidæ are more or less of normal form, would appear to be considerably diminished by the rather distinctly marked segmentation of the upwardly deflected section, accompanied by no great attenuation of the centra, met with in *P. shannonensis*, and by the existence, though to a less marked degree, of an essentially similar state of affairs in young individuals of *G. attenuatus*. It is of interest to observe, incidentally, that in immediately post-larval examples of the lastnamed species the upward flexure of the distal end of the vertebral axis is clearly indicated during life by the course of a line of dark pigment deposited along the superior border of the notochordal sheath.

Key to Subfamilies, Genera, and Subgenera of Galaxiidae Here Considered

A. Dorsal fin inserted well back (about over anal fin); teeth in the jaws uniserial, vertebrae > 50 .... Subfamily *GALAXIINAE*

B. Teeth present on entopterygoids; dorsal and anal fins relatively high .... Genus *Galaxias*

C. Pelvic fin with seven rays .... Subgenus *Galaxias*

CC. Pelvic fin with six rays .... Subgenus *Agalaxis*

[CCC. Pelvic fin with five rays .... *Galaxias bullocki* Regan]

BB. No teeth on entopterygoids; dorsal and anal fins relatively low:

D. Pelvic fins present .... Genus *Saxilaga*

E. Pelvic fin with six rays; lingual teeth biserial .... Subgenus *Saxilaga*

EE. Pelvic fin with five rays; lingual teeth in more than two series .... Subgenus *Lixagasa*

[DD. Pelvic fins absent

F. Anal and dorsal fins subcontinuous with caudal fin .... Genus *Neochanna*]

AA. Dorsal fin inserted well forward (about over pelvic fin); teeth in the jaws biserial or uniserial; [vertebrae < 50 in *P. shannonensis*].... .... Subfamily *PARAGALAXIINAE*

G. Teeth in the jaws biserial .... Genus *Paragalaxias*

[GG. Teeth in the jaws uniserial .... *Galaxias dissimilis* Regan]

Family GALAXIIDAE

Subfamily *GALAXIINAE*, nov.

Diagnosis. Dorsal fin inserted well back, about over anal fin, the length to origin of dorsal being about two-thirds of total length. Pelvic fins present or absent. Premaxillary and mandibulary teeth uniserial. Entopterygoids toothed or toothless. Lingual teeth in two or more series. Vertebrae more than 50.

Type-genus. Galaxias Cuvier, 1817.

The subfamily includes *Galaxias* Cuvier, *Neochanna* Günther, and *Saxilaga*, nov.

Genus **Galaxias** Cuvier, 1817

Galaxias Cuvier, *Règn. Anim.* ed. 1. II. 1817. p. 183.[1]
Mesites Jenyns, *Zool. Voy. Beagle.* III. *Fish.* 1842. p. 118. Preoccupied by *Mesites* Geoffroy, 1838 (Aves), and *Mesites* Schoenherr, 1838 (Coleoptera).
Austrocobitis Ogilby, *Proc. Linn. Soc. N.S.W.* XXIV. 1899. p. 158. Substitute for *Mesites* Jenyns, preoccupied.

Diagnosis. Body more or less elongate. Dorsal fin inserted well back; free of caudal; relatively high; with 9-15 rays, which are mixed (simple and branched). Anal fin partly below dorsal; free of caudal; relatively high; with 10-19 mixed rays. Pelvic fins present; with 7, 6, or 5 rays. Premaxillary and mandibulary teeth uniserial, conical, pointed. Entopterygoids each with a single series of teeth. Lingual teeth biserial. Eye fairly large to small; with free circular lid. Vertebrae 53-64, *fide* Regan (1906, p. 365).

Haplotype. Esox truttaceus Cuvier.

Subgenus **Galaxias**, nov.

Diagnosis. Pelvic fin with 7 rays.

Orthotype. Esox truttaceus Cuvier = *Galaxias (Galaxias) truttaceus* (Cuvier).

This, the typical and dominant section of the family, includes 24 of the 27 species of *Galaxias* regarded by Regan in his revision as well established, a total since considerably extended. McCulloch (1929) admitted 18 Australian species, including the 5 species accredited by authors generally to Tasmania, to which 3 species are here added. Phillipps (1926 (a)) listed 8, and later (1927) 7 New Zealand species, and Regan (1913) noted 6 species from South American localities, referable to this subgenus.

[1] McCulloch (1929, p. 47), citing this reference, gives the date as '"1817" = Dec. 1816', and adopts 1816 as the date of publication of the genus. Sherborn, however, in his bibliography (*Index. Anim.* 1801-1850. I. 1922. p. xli) seems clearly to indicate that only vol. 1 of the first, or "1817", edition was published in Dec., 1816, and in his systematic text (XI. 1926. p. 2621) formally gives 1817 as the date for *Galaxias* Cuvier. Sherborn has questioned the validity of this edition, noting 'it abounds in vernaculars'; and has observed that 'Cuvier's vernac. are latinized and available for first time by Schinz', *i.e., Das Thierreich.* 4 vols. Stuttgart. 1821-1825 (vol. 2, with *Galazias*, 1822).

Distribution. Australia, and neighbouring islands; Tasmania, and neighbouring islands; New Zealand and neighbouring, and sub-antarctic, islands; Falkland Islands; Tierra del Fuego; Patagonia, and neighbouring islands; Argentina; Chile; &c.: not South Africa. [*G. neocaledonicus* Weber and De Beaufort, which, if retained in *Galaxias*, would be, to judge from the original account in the *Zoologischer Anzeiger*, XLII, 1913, p. 173, referable to this subgenus, is from Southern New Caledonia.]

Galaxias (Galaxias) truttaceus (Cuvier)

Esox truttaceus Cuvier, *Règn. Anim.* ed. 1. II. 1817. p. 184.
Galaxias ocellatus McCoy, *Intercol. Exhib. Essays.* 7. 1866. p. 14.

Distribution. Tasmania, and neighbouring islands; Victoria: not New Zealand. Type-locality (by present designation): Agnes River, South-Eastern Tasmania.

In the Check-List McCulloch (1929, p. 48) gives the original reference to this species as—'1816. *Esox truttaceus* Cuvier, *Règn. Anim.*, ed. 1, II, "1817" = Dec. 1816, p. 184; ed. 2, II, 1829, p. 283. *Ex Esox alepidotus* Forster MS. No locality [= New Zealand].'

Realizing that an error had somehow crept in, apparently arising from some confusion regarding *Esox alepidotus* Forster MS., and believing that the type-locality should certainly be Tasmania, I have communicated with Mr. G. P. Whitley, Ichthyologist, Australian Museum, Sydney, who agrees with me that the designation of New Zealand is incorrect, and has very kindly supplied the greater part of the bibliographical data discussed below.

Disregarding the interesting side-issues that arise in connexion with the status of *E. argenteus* Gmelin, *E. argenteus* Forster MS., *E. alepidotus* Forster, and *G. forsteri* Cuvier and Valenciennes, the position in regard to *G. truttaceus* may be summarized as follows. (*a*) In the first edition of Cuvier (1817, pp. 183-184) we find the first publication of the names *Galaxias* and *Esox truttaceus*—*i.e.*, the generic and specific names of the present form, the former in the heading (p. 183) to the description, 'Les Galaxies. (Galaxias. Cuv.)', the latter in a footnote (p. 184), '*Esox truttaceus* Cuv. espèce nouvelle, ou peut-être l' *es. argenteus* Forster?' (*b*) Here, it is to be noted, no locality is given, nor is there any mention of *Esox alepidotus* Forster as such. (*c*) Mr. Whitley remarks that at that date the French had little knowledge and very few specimens of New Zealand fauna, and surmises that Forster's MS. description of *alepidotus* was probably in Berlin. (*d*) In the second edition of Cuvier (1829, p. 283) the description of the genus is the same as that in the first, but the footnote reads, '*Esox truttaceus* Cuv.;—*Esox alepidotus* Forst.', indicating that Cuvier considered these two (separate) species belonged to *Galaxias:* no localities are given. This account is translated as it stands by Voigt (1829). (*e*) In the German edition of Cuvier by Schinz (1822, p. 309), a translation and enlarge-

ment of the first edition, in which Cuvier's names are latinized, the combination *Galax (ias) truttaceus* appears for the first time. (*f*) In the second (the only accessible) edition of Cuvier and Valenciennes (1846, p. 253) appears the following passage. 'Le genre Galaxie est une création de M. Cuvier; il l'a établi sur un petit poisson, rapporté de la Nouvelle-Holland par MM. Péron et Lesueur, et qui a été ensuite retrouvé par MM. Quoy et Gaimard. Ces deux chirurgiens de la marine royale nous apprirent que le poisson de Péron vivait dans les eaux douces de la terre de Van-Diemen'. (*g*) These facts, particularly (*f*), seem clearly to show that the type-locality of New Zealand, given by McCulloch, is erroneous, and further, that it should be 'fresh water, Tasmania'. There seems to me little doubt that the type-material of the species was collected in the D'Entrecasteaux Channel district during the visit of Baudin's expedition, January 13th - February 17th, 1802. This would presumably be now in the Paris Museum. Dealing with an excursion made by a party in the neighbourhood of the 'Rivière Fleurieu' inland from 'le port des Cygnes', Péron (1807, p. 234) remarks, '. . . . ils y avaient aussi vu de nombreuses truites; et M. Lesueur m'en rapportoit quelques-unes qu'il avoit tuées d'un coup de fusil'. It seems very probable that these 'truites' were *Galaxias truttaceus*, and, on the evidence available, I venture to redesignate the type-locality of this species as Agnes River (Rivière Fleurieu of Péron), South-Eastern Tasmania. It should be noted that elsewhere Péron (1824, p. 73) mentions *Esox* among marine fishes and sharks, the reference, which may be presumed not to be a Galaxiid, possibly relating to *Dinolestes*, or *Sphyraena*.

Galaxias (Galaxias) attenuatus (Jenyns)

Mesites attenuatus Jenyns, *Zool. Voy. Beagle*, III. *Fish*. 1842. p. 121. pl. XXII. fig. 5.
Austrocobitis attenuatus Ogilby, *Proc. Linn. Soc. N.S.W.* XXIV. 1899. p. 158.
Galaxias attenuatus Regan, *Proc. Zool. Soc.* 1905. II. (1906). p. 368. pl. XII. fig. 1 and pl. XIII. fig. 2. (references and synonymy).

Distribution. Queensland (Marshall, 1928); New South Wales; Victoria; South Australia; Tasmania, and neighbouring islands; New Zealand, and neighbouring islands; Falkland Islands; Tierra del Fuego; Patagonia; Chile; &c. Type-locality: Bay of Islands, New Zealand.

Galaxias (Galaxias) rostratus Klunzinger

Galaxias rostratus Klunzinger, *Arch. Naturges.* XXVIII. 1. 1872. p. 41.

Distribution. South Australia. Type-locality: Murray River, South Australia.

Remarks. Regan (1906, p. 378), in error, cites the type-locality as 'Mersey River', thus suggesting a Tasmanian habitat: fortunately, this slip has not crept into any of our faunal lists. The species, incidentally, does not seem to have been recognized since its description more than sixty years ago.

Galaxias (Galaxias) auratus Johnston

Galaxias auratus Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883). pp. 62 and 131.

Distribution. Tasmania. Type-locality: Great Lake, Tasmania.

Remarks. In Johnston's MS., made available by Whitley (1929, p. 48), there appears under the record of *G. atkinsoni* ('Pieman River, Tasmania, 28th Nov., '79. T. R. Atkinson') a subsequently added note: 'Mr. Irving, in early May, 1894, sent me from Great Lake one of several specimens almost identical with the above, as regards dusky bar markings, but close to the characters of *G. attenuatus* in other respects'. Unless the resemblance to *G. attenuatus* was of a most superficial character, I am at a loss to make a conjecture as to the identity of this specimen. If, however, the observation was the result of quite a casual inspection, signifying, for instance, little more than the body was slender, and the mouth small, there seems a possibility that the specimen might have been a young example of *G. (G.) parkeri*: but the available evidence is of too uncertain a character to be invested with any taxonomic significance.

Galaxias (Galaxias) weedoni Johnston

Galaxias weedoni Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883). p. 131.
? *Galaxias atkinsoni* Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883). p. 131.

Distribution. Tasmania. Type-locality: Mersey River, Tasmania.

Remarks. The relegation by Regan of *G. (G.) atkinsoni* to the synonymy of *G. (G.) weedoni* has been generally followed by Australian authors, *e.g.*, McCulloch (1929), Lord and Scott (1924, p. 33). Further evidence, particularly data derived from adult specimens, appears to be required, however, before the status of the species can be satisfactorily determined. The type-locality of *G. (G.) atkinsoni*—spelt *atkinsonii* by Regan (pp. 377 and 378)—is Pieman River, Tasmania: the specimens discussed by Regan came from Lake Laura.

In Johnston's memoranda, redacted by Whitley (1929, p. 47), there is included under the heading of *G. auratus* a note on a 'Mountain Trout. Lake Sorell'. Though it might naturally be presumed Johnston would be quite clear on the limits of one of his own species, I have, nevertheless, a suspicion that the specimen in question may possibly be referable to *G. (G.) affinis* Regan. The whole matter, however, appears too vague to warrant even a queried inclusion of the reference in the synonymy.

Galaxias (Galaxias) affinis Regan

Galaxias affinis Regan, *Proc. Zool. Soc.* 1905. II. (1906). p. 380, pl. X. fig. 1.

Distribution. Tasmania. Type-locality: Lake St. Clair, Tasmania.

Remarks. I have previously (1934, p. 39) called attention to the omission of this species from the Tasmanian lists of Lord (1923) and Lord and Scott (1924).

Galaxias (Galaxias) johnstoni, sp. nov.

(Text-fig. 1)

B. 8 [8-9]. D. III, 7 [III, 6-7]. A. III, 7 [III, 6-7]. P. 12 (IV, 8). V. 7. C. 14, II + $\frac{\text{IX} +}{\text{IX} +}\left[\text{14, II} + \frac{c.\ \text{VIII} - \text{X}}{c.\ \text{IX} - \text{XI}}\right]$. Gill-rakers on lower limb of anterior arch 8 [7-8], moderately stout, fairly short.

Depth of body, 6·9 [7·2-7·6] in total length, 5·9 [6·1-6·6] in standard length. Head 5·9 [5·4-5·5] in total length, 5·0 [4·6-4·8] in standard length. Snout 3·4 [3·8-4·3] in head. Eye 1·4 [1·0-1·3] in snout, 2·3 [1·9-2·1] in interorbital width, 4·8 [4·3-4·6] in head. Depth of caudal peduncle 1·4 [1·4-1·7] in its length, 2·1 [2·3-2·4] in head. Length of caudal peduncle 1·4 [1·4-1·5] in its superior length (*i.e.*, interval between termination of dorsal and hypural joint), 1·3 [1·2-1·3] times base of dorsal.

Body rather slender; greatest width 1·1 [1·1-1·2] in greatest depth. Head moderate; greatest depth 1·1 [1·1-1·2] in greatest width; depth at eyes 1·1 [1·1-1·3] in width there, the latter dimension being 1·1 [1·0-1·1] times length of postorbital portion of head. Eye rather small. Interorbital region almost flat. Snout obtuse, little depressed; jaws equal [equal-subequal] anteriorly. Maxillary extending almost to level of middle [anterior ⅓—almost middle] of eye. Tubular anterior nostril nearly as wide as high; equidistant from anterior margin of upper lip and eye. Simple posterior nostril slightly in advance of, barely above, eye; nearly thrice as far from anterior nostril as from orbit.

Pores along midlateral line about 29 + 23, one to each myomere, decreasing in size caudad.

Lingual teeth rather large. Pterygoidal teeth moderate. Premaxillary teeth rather small, subequal. Mandibulary teeth moderate, somewhat enlarged laterally.

Dorsal fin moderate, fairly high; base 2·0 [1·8-1·9] in head, subequal to postorbital portion of head; longest (2nd [2nd-1st] branched) ray 1·3 [1·6-1·7] in head, more than twice snout; distance from its origin to base of caudal 4·1 [3·4-3·8] in total length, 3·5 [2·9-3·1] in standard length; laid back, extends less than half-way along superior profile of peduncle, barely reaching origin of caudal ridge.

Anal fin subequal to dorsal; base 1·8 [1·8] in head, less than caudal peduncle; longest (2nd [2nd-1st] branched) ray 1·3 [1·4-1·6] in head, less than depth of body; originating behind origin of dorsal by 0·5 [0·5-0·6] of base of latter; terminating behind base of dorsal by 0·6 [0·6] of latter; laid back, extends scarcely half-way along peduncle, reaching well past origin of caudal ridge.

Pectoral fin moderate, obtusely pointed; longest (5th [5th]) ray 1·3 [1·5-1·6] in head; extending 0·6 [0·5-0·6] of distance from its origin to origin of pelvic.

Pelvic fin moderate; longest (4th [4th]) ray 1·6 [1·7-2·0] in head; originating midway between base of caudal and anterior margin of eye; length to its origin 2·2 [2·1-2·2] in total length, 1·9 [1·8-1·9] in standard length; extending 0·6 [0·6-0·7] of distance from its origin to origin of anal.

Caudal fin moderate; emargination 10 per cent. [9-12 per cent.]; length 1·1 [1·2-1·4] in head. Caudal ridges well developed; extension cephalad from level of hypural subequal to median caudal rays.

Total length 71 mm. [49-50·5 mm.]; standard length 60·5 mm. [42·5-43 mm.].

Ground colour in life translucent greenish, becoming greyish white, shot with silvery gold, below. Back and sides irregularly blotched, obscurely barred, and reticulated with brownish. In the holotype (Text-fig. 1) and in one paratype, viewed laterally, the much-reticulated dark colour-pattern, the area of which equals, or slightly exceeds, that of the interspaced ground colour, descends, behind vent, to ventral profile, but, in advance of vent, ceases at about one-third

Fig. 1.—*Galaxias (Galaxias) johnstoni*, sp. nov. Holotype. Near Nive River, Tasmania. (× 1½.) [Parasites not shown.]

of the body-height above ventral profile, the line of demarcation being moderately sharp. In two paratypes the broad bars of the dark colour-pattern, the area of which greatly exceeds that of the interspaced ground colour, cease above the ventral profile throughout the entire length, the line of demarcation being decidedly sharp. Dorsal markings similar to lateral, meeting a well-defined narrow median stripe of gold, extending from nape to dorsal origin: in preserved specimens this stripe, along which the body becomes sunken to form a groove, appears as a continuous, or subcontinuous, dark streak. Whole body lavishly and brilliantly punctuated with metallic gold. Head in general concolorous with body, with darker patches between and behind eyes, where there is much scattered gold, at bases of anterior nostrils, and on tip of snout; ventral surface concolorous mesially with that of body, darker laterally; lower lip scarcely lighter than upper, the latter concolorous with general dorsal surface of snout. Operculum with conspicuous metallic gold blotch. A narrow gold annulus surrounding pupil; iris otherwise blackish

with purplish cast. No suborbital dark streak. Enteric canal metallic greenish gold. All fins immaculate, golden, in some lights presenting a metallic appearance.

Specific name in honour of Robert Mackenzie Johnston, the father of Tasmanian ichthyology, who paid considerable attention to the local Galaxiidae.

Types. Described from the holotype (Text-fig. 1) in the Queen Victoria Museum, Launceston (Reg. No. HT 948), and from three paratypes, the variations exhibited by which are recorded throughout in square brackets. Paratypes will be offered to the British Museum (Natural History), London; Australian Institute of Anatomy, Canberra; Australian Museum, Sydney.

Locality. Creek crossing the Hobart-Queenstown road, about three and three-quarter miles westward from the Nive Bridge; 31st March, 1934.

Affinities. It is convenient here to observe that the Tasmanian representatives of the subgenus fall naturally into three sections: the *truttaceus* group, comprising that species, *auratus*, and *scopus*; the *weedoni* group, comprising that species (and *atkinsoni*, if distinct), *johnstoni*, *parkeri*, and, rather towards the fringe of the assemblage, *affinis*; and the *attenuatus* group, represented locally by that species only. While the familiarity acquired from handling of actual specimens renders the relegation of any species to its appropriate group a simple matter, a formal and precise delimitation of the groups naturally presents some little difficulty. Broadly speaking, however, and allowing for occasional exceptions to individual diagnostic points, the members of the *truttaceus* group exhibit the following characters:—rather small mouth; pelvic fins inserted well back; anal fin set well forward, relative to dorsal; anal and dorsal not pointed, without macroscopic spots, often blackish distally; colour-pattern not extensive, usually in the form of spots, which are often ocellated; suborbital dark streak; relatively little metallic gold in life: members of the *weedoni* group exhibit.—rather large mouth; pelvic fins inserted moderately to well forward; anal fin set below about middle of dorsal; anal and dorsal more or less pointed, often with macroscopic spots, not blackish distally; colour-pattern extensive, usually in the form of bars, chevrons, blotches, or reticulations, seldom in spots, which, in any case, are never ocellated; no suborbital dark streak; a considerable amount of metallic gold in life: members of the *attenuatus* group (including extralimital species, *e.g.*, *G. gracillimus*, *G. maculatus*) differ from the two preceding groups by, among other characters, the small mouth, elongated body, origin of anal vertically below that of dorsal (*cf.*, however, *G. scopus*), large number of anal rays, and nature of colour-pattern.

G. (G.) johnstoni is distinguishable from all other members of the *weedoni* group by its colour-pattern. It further differs from *G. (G.) weedoni* (and *G. (G.) atkinsoni)* in the radial formulae of anal, dorsal, and pectoral; from *G. (G.) parkeri* in having fewer anal rays, jaws equal anteriorly; from *G. (G.) affinis* in having fewer anal rays, &c.

Parasites. The holotype is parasitized to a slight extent by an Opisthorchiid trematode (not shown in figure), probably congeneric with the *Clonorchis* noted by Whitley (1935, p. 51) as occurring in Galaxiids and in *Retropinna.* The distomes are encysted in the immediately subdermal tissue and the fin-membranes, where they induce local melanosis. A few scattered cysts are observable, particularly on the caudal fin, in each of the paratypes.

As Regan (1906, p. 364) has pointed out, ' in some species ' of *Galaxias* these ' numerous small blackish spots on the body and fins are almost always present, and have been mistaken for colour-markings characteristic of the species (*e.g., G. lynx* and *G. olidus*)'.

Galaxias (Galaxias) scopus, sp. nov.

(Text-fig. 2)

B. 8 [9]. D. IV, 8 [IV, 8]. A. IV, 10 [IV, 12]. P. 16 [15]. V. 7. C. 14, II $+\frac{\text{VIII}+}{\text{VII}+}\left[\right.$ 14, II $+\frac{\text{IX}+}{\text{IX}+}\left.\right]$. Gill-rakers on lower limb of anterior arch 10 [11], long, slender.

Depth of body 6·6 [6·3] in total length, 5·5 [5·3] in standard length. Head 5·5 [5·7] in total length, 4·6 [4·8] in standard length. Snout, 3·6 [3·6] in head. Eye 1·2 [1·2] in snout, 1·9 [2·1] in interorbital width, 4·3 [4·4] in head. Depth of caudal peduncle 1·1 [1·2] in its length, 2·1 [2·1] in head. Length of caudal peduncle 1·5 [1·4] in its superior length, 1·3 [1·1] times base of dorsal.

Body stout; greatest width 1·2 [1·2] in greatest depth. Head moderate; greatest depth 1·0 [1·0] in greatest width; depth at eyes 1·0 [1·0] in width there, the latter dimension being 1·2 [1·3] times length of postorbital portion of head. Eye moderate. Interorbital region convex. Snout obtuse, little depressed; jaws equal anteriorly. Maxillary extending to level of anterior ¾ [⅔] of eye. Tubular anterior nostril higher than wide; about twice as far from eye as from anterior margin of upper lip. Simple posterior nostril above, and well in advance of, eye; nearer to orbit than to anterior nostril.

Pores along midlateral line about 40 + 22, one to each myomere.

Lingual teeth moderate. Pterygoidal teeth moderate. Premaxillary teeth fairly large, increasing somewhat in size laterally. Mandibulary teeth moderate; several more or less distinctly enlarged lateral canines; an enlarged tooth on either side near the symphysis.

Dorsal fin rather small, fairly high, base 2·4 [2·0] in head, less than, or equal to, postorbital portion of head; longest (3rd [3rd] branched) ray 1·5 [1·3] in head, two and a half times snout; distance from its origin to base of caudal 4·6 [4·6] in total length, 3·9 [3·8] in standard length; laid back, reaches half-way along superior profile of peduncle, extending beyond origin of caudal ridge.

Anal fin much longer, slightly higher, than dorsal; base 1·4 [1·4] in head, noticeably more than caudal peduncle; longest (2nd [3rd] branched) ray 1·3 [1·2] in head, more than half anal-pelvic interspace; originating behind origin of dorsal by 0·05 [0·0] of base of latter; terminating behind base of dorsal by 0·6 [0·6] of latter; laid back, extends three-fourths of the way along peduncle, reaching beyond anterior procurrent ray.

Pectoral fin moderate, rounded; longest (5th [6th]) ray 1·5 [1·4] in head; extending 0·5 [0·5] of distance from its origin to origin of pelvic.

Pelvic fin moderate; longest (3rd [3rd]) ray 1·8 [1·7] in head; originating midway between base of caudal and a point between orbit and anterior nostril [equidistant from base of caudal and eye]; length to its origin 2·3 [2·2] in total length, 1·9 [1·8] in standard length; extending 0·6 [0·6] of distance from its origin to origin of anal.

Caudal fin moderate; emargination [about 20 per cent.]; length 1·1 [1·1] in head. Caudal ridges well developed; total depth at level of hypural greater than [equal to] length of caudal peduncle.

Total length 129 mm. [114 mm.]; standard length 108·5 mm. [96 mm.].

Ground colour in formalin faintly bluish grey. Ventral surface in holotype ivory with minute dark punctulations, scarcely apparent to the naked eye; in paratype obscurely brownish from the presence of numerous stellate black pigment-spots. Holotype with lower half, or more, of sides behind level of dorsal origin with distinct yellowish suffusion. A dark, sharply defined postpectoral bar or blotch, preceded (right side of holotype), or followed (left side of holotype), or encircled (both sides of paratype) by a narrow region of pale sulphur yellow. Back and sides with numerous circular or elliptical dark purple spots of several sizes, the great majority conspicuously annulated with sulphur yellow. On the sides in advance of the anal base these cease below at about the horizontal level of middle pectoral base, but cover the whole caudal peduncle, on which the large spots are of greater dimensions than elsewhere, while small spots are few, or absent. The whole interspace between the spots, including the light-coloured annuli, thickly covered with blackish punctulations, somewhat more sparsely set in the holotype on the lower part of the caudal peduncle. Occipital region, cheek, and

opercle concolorous with dorsal and lateral aspects of body; ventral surface of head concolorous with ventral surface of body; interorbital region and dorsal surface of snout darker than rest of head, markedly so in paratype, in which they are black. Upper lip very dark, almost black; posterior half of lower lip lighter than, anterior half almost concolorous with, upper lip. Broad oblique suborbital dark streak. Dorsal and anal fins with about the proximal third abundantly punctulated greyish; remainder, except tips, which are blackish, immaculate and with some indication of having been yellowish in life. Pectoral fins with membrane sparsely pigmented at base, immaculate elsewhere; rays with lateral and some medial pigmentation, rendering them somewhat dusky. Pelvic fins mainly hyaline, with small faintly ashen basal region; tips blackish. Caudal fin in holotype slightly, in paratype moderately, dusky; a dark basal region; in paratype distal region narrowly blackish. Caudal ridges minutely and abundantly punctulated: in holotype upper ridge with four or five dark spots; in paratype upper and lower ridges each with one or two spots.

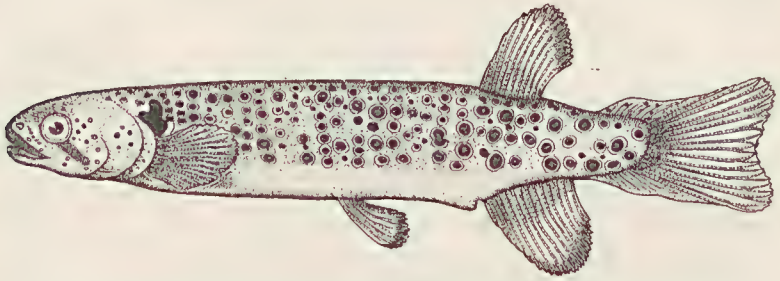

Fig. 2.—*Galaxias (Galaxias) scopus*, sp. nov. Holotype. Clarke Island, Bass Strait. (× ¾.)

Scopus, a target—in allusion to the general suggestion of resemblance, arising from the irregular, crowded distribution of the spots, to a target riddled with bullets.

Types. Described from the holotype (Text-fig. 2), in the Queen Victoria Museum, Launceston (Reg. No. HT 949), and from one paratype, which will be offered to the British Museum (Natural History), London.

Locality. Clarke Island, Bass Strait. Holotype from a 'small brackish-water stream, running very slowly indeed in hot summers, and forming a six feet deep by 400 yards long lagoon at the mouth', the specimen being caught on the 18th January, 1935, 'about 100 yards above this creek-lagoon in a rocky pool, making the distance from the sea just over a quarter of a mile'; (Mr. A. Maclaine). Paratype from another creek, flowing eastward, 'about 200-300 yards from sea; water definitely brackish', February, 1935; (Mr. G. Maclaine).

Distribution. Among some Galaxiid material recently received on loan for examination from the Australian Museum, Sydney, through the courtesy of the Director, Dr. C. Anderson, were two undetermined specimens from Flinders Island, collected many years ago by Mr. A. S. Le Souef. One of these (Aus. Mus. Reg. No. 1.A.3913), about 140 mm. in total length, is clearly *G. (G.) attenuatus*; the other (Aus. Mus. Reg. No. 1.A.3912), the total length of which is of the order of 120 mm., is possibly referable to the present species, but is in too poor a state of preservation to admit of definite determination.

Affinities. *G. (G.) scopus* is clearly a member of the *G. (G.) truttaceus* group, from all other members of which, however, it is at once distinguished by the origin of the anal being below, or very slightly behind, the level of the dorsal origin.

It is nearest to *G. (G.) truttaceus*, from which it differs mainly in the relative positions of the anal and dorsal, as noted above, and in the more lavish spotting. Apart from these characters, it closely resembles that species, and, on the evidence afforded by the holotype alone, might naturally be suspected to be possibly merely a regional, subspecific variant of it. The subsequent capture, in the same creek as that from which the paratype was obtained, of a quite characteristic specimen of *G. (G.) truttaceus* would seem to indicate, however, that *G. (G.) scopus* is a distinct species.

Remarks. The important diagnostic character of the point of origin of the anal relative to that of the dorsal may probably be with advantage the subject of more precise investigation than it has customarily received hitherto: it is not unlikely that the adoption of a convenient quantitative notation, followed by its application to extensive series of specimens, may prove of value, not only in indicating specific, but also in revealing and assessing subspecific, differences, the latter, incidentally, being a taxonomic aspect that is as yet scarcely touched upon in the case of members of the present order.

In the formulae discussed below, D and d denote, respectively, length to origin, and to termination, of base of dorsal; A and a, respectively, length to origin, and to termination, of base of anal; T, total length; S, standard length (*i.e.*, from tip of snout to hypural joint). Employing a slight modification of the expression $\frac{a-d}{t} \times 100$ (a = length to vent; d = length to dorsal; t = total length) used with striking success by Schmidt (1928) in the investigation of our Australian eels, we find $\frac{A-D}{T} \times 100$ gives the following values: *G. (G.) scopus* 0-0·4; *G. (G.) truttaceus* (one specimen, total length 134 mm.; Clarke Island) 2·6; *G. (G.) truttaceus* (ten specimens, total length 82-141 mm.; various Tasmanian localities) 2·1-3·1, av. 2·4.

Substituting S for T, the values, noted in the same sequence, are: 0-0·5; 3·1; 2·4-3·6, av. 2·8. After making trial of various formulae, involving such factors as head-length, eye-diameter, length and depth of caudal peduncle, pelvic-anal interspace, and so on, I find perhaps the most useful to be $\frac{A - D}{(d - D) + (a - A)} \times 100$: this yields satisfactorily consistent results, with the values of a convenient magnitude, and, further, introduces the appropriate factors of the lengths of the bases of the fins under consideration. The values derived from this formula, in sequence as before, are: 0-2·0; 14·3; 10·6-14·5, av. 11·9.

Galaxias (Galaxias) parkeri, sp. nov.

(Text-fig. 3)

B. 8 [8-9]. D. IV, 7 [IV-V, 6-9]. A. IV, 9 [IV-V, 7-9]. P. 14 [14-15]. C. $14, II + \frac{c.\ X}{c.\ IX}\left[14, II + \frac{V + - IX}{V + - X}\right]$. Gill-rakers on lower limb of anterior arch 9 [8-9], fairly long.

Depth of body 7·2 [5·9-12·0] in total length, 6·2 [5·0-10·3] in standard length. Head 5·3 [5·2-6·9] in total length, 4·5 [4·5-5·9] in standard length. Snout 3·3 [3·1-3·8] in head. Eye 1·3 [1·2-1·9] in snout, 1·9 [1·6-2·6] in interorbital width, 4·3 [3·9-6·2] in head. Depth of caudal peduncle 1·5 [1·3-1·7] in its length, 2·2 [2·0-3·1] in head. Length of caudal peduncle 1·5 [1·2-1·4] in its superior length, 1·8 [1·4-1·8] times base of dorsal.

Body rather slender; greatest width [1·0-1·2] in greatest depth. Head moderate; greatest depth 1·1 [1·1-1·3] in greatest width; depth at eyes [1·1-1·4] in width there, the latter dimension being [1·0-1·3] times postorbital portion of head. Eye moderate. Interorbital region almost flat, or even slightly concave. Snout obtuse, much depressed; upper jaw protecting beyond lower. Maxillary extending to level of middle [anterior margin or barely beyond, in small paratype — anterior ⅓ or middle in larger paratypes] of eye. Tubular anterior nostril a little higher than wide; rather nearer anterior margin of upper lip than eye. Simple posterior nostril level with, or slightly in advance of, eye, barely above eye; about thrice as far from anterior nostril as from orbit.

Pores along midlateral line about 41 + 20, one to each myomere.

Lingual teeth rather small. Pterygoidal teeth rather small to moderate. Premaxillary teeth moderate, subequal. Mandibulary teeth moderate, scarcely enlarged laterally.

Dorsal fin rather short, of moderate height; base 2·7 [1·6-2·7] in head, rather more than, or subequal to, postorbital portion of head; longest (1st [1st-2nd] branched) ray 1·6 [1·6-2·1] in head, slightly

more than [subequal to] twice snout; distance from its origin to base of caudal 4·0 [3·8-4·3] in total length, 3·4 [3·2-3·6] in standard length; laid back, extends less than half-way along superior profile of peduncle, barely, or not, reaching origin of caudal ridge.

Anal fin rather longer than, subequal in height to, dorsal; base 2·1 [1·4-2·5] in head, less than caudal peduncle; longest (2nd [2nd-3rd] branched) ray 1·6 [1·5-2·0] in head, less than depth of body; originating behind origin of dorsal by 0·5 [0·5-0·6] of base of latter; terminating behind base of dorsal by 0·7 [0·5-0·7] of latter; laid back, extends half-way, or less, along caudal peduncle, reaching beyond, or barely to, origin of caudal ridge.

Pectoral fin moderate, obtusely pointed; longest (6th [6th-8th]) ray 1·6 [1·4-1·9] in head; extending 0·5 [0·4-0·6] of distance from its origin to origin of pelvic.

Pelvic fin moderate; longest (4th [4th]) ray 1·5 [1·3-1·9] in head; extending 0·6 [0·4-0·6] of distance from its origin to origin of anal. The point of insertion exhibits considerable variation, correlated, in the main, with size: in the holotype it is about equidistant from base of caudal and anterior margin of eye; in the larger and moderate-sized paratypes it lies midway between base of caudal and vicinity of anterior nostril; while in small paratypes (and in other small individuals, including one of the 12 specimens, 42-50 mm. in length, forwarded to the British Museum by Mr. Critchley Parker, which I have been able to examine through the courtesy of Mr. J. R. Norman) it lies at, or even decidedly in advance of, the middle of the standard length. Length to origin is hence rather variable, being 2·2 [2·1-2·4] in total length, 1·9 [1·9-2·1] in standard length.

Caudal fin moderate; emargination 14 per cent. [14-19 per cent.]; length 1·4 [1·0-1·6] in head. Caudal ridges well developed; extension cephalad from level of hypural subequal to median caudal rays.

Total length 79 mm. [45-113 mm.]; standard length 68 mm. [38·5-99 mm.].

Colour of holotype (in alcohol) pale brownish, heavily barred with dark slate grey, the number (round about ten) and size of the bars differing on the two sides; the widest bar, near the dorsal fin, involves about ten myomeres, its width being about equal to the length of the pectoral. At level of midlateral line, the bars of ground colour vary in breadth from about one-quarter, anteriorly, to one-third or one-half, posteriorly, of the width of the dark bars. The dark areas, which, except on and near the caudal peduncle, fail to reach the ventral profile, are continued up from the sides in irregular broad saddles over the back. A narrow bluish postpectoral bar. Lower lateral and ventral aspects of body yellowish white, punctulated with bluish grey, except for an immaculate median area, less than one-third as wide as the body, that extends from level of pectorals nearly to level of pelvics. Sides of head in general concolorous with sides of body; an ill-defined dark spot on operculum, the postero-inferior

portion of which latter is lighter than most of head; dorsal surface in general concolorous with sides, but with darker interocular and occipital patches; lower lip rather lighter than upper. No suborbital dark streak. Dorsal and anal fins immaculate macroscopically; yellowish grey, darker and with tinges of green basally, where there is abundant dark punctulation; well-developed ridges, probably originally yellowish, extending up between the rays for about three-quarters of their length. Pectoral and pelvic fins immaculate macroscopically; yellowish grey, somewhat dusky distally; scattered punctulations near base. Caudal fin pale yellowish grey, somewhat dusky distally; a few punctulations on proximal third.

Colour in life of a large paratype, 77·5 mm. in total length (*i.e.*, about same size as holotype), brown, more or less olivaceous; barred and blotched with darker brown, becoming somewhat greenish anteriorly. Along mid-dorsal line, from nape to origin of dorsal, a linear series of about eight narrow dark brown stripes, narrowly margined on either side with gold specks. A dark brown midlateral ridge clearly traceable backwards to origin of dorsal. Sides below midlateral line moderately punctulated with gold. Narrow dark postpectoral bar. Ventral surface pale green. Head in general concolorous with body; dorsal surface of snout a characteristic pale jade green, with golden spot near base of each anterior nostril; upper lip dark greenish, faintly brown; lower lip pale greenish. Operculum with golden green blotch, not very sharply delimited. Iris silvery green, much punctulated, especially above, with brown. No suborbital dark streak. Dorsal and anal fins green proximally, brown-orange mesially, ashen distally. Pectoral fin brownish, with a narrow almost white region at tip, and extending somewhat inwards along postaxial border. Pelvic fin similar to pectoral, but with two or three of the anterior rays darker distally. Caudal fin rich brown, with a suffusion of orange; ashen distally; rays rich brown up to the bifurcation, thereafter either ashen or dusky.

The ground colour in life of moderate-sized specimens (50-60 mm. in total length) is commonly green, varying in depth in different individuals; body-markings dark green. Fins mainly greenish or hyaline. Other details much as in large paratype described above.

Specimens of about the size of the smallest paratype (45 mm. in total length), and smaller, are in general pale greenish, translucent—appearing, however, much darker, almost dark greenish brown, when viewed swimming at some distance below the surface. The colour-pattern varies greatly, and may be well-developed, inconspicuous, or almost entirely absent. Small black spots on dorsal surface, irregularly scattered, except for two well-marked rows embracing base of dorsal fin. Narrow dark midlateral line. Snout translucent, often faintly greenish; olfactory sacs metallic green-gold punctulated with blackish. Occipital patch green-gold, submetallic. Superior aspect of ocular capsules orange-gold, scintillant—a very conspicuous feature

in life, the spots being clearly visible even under a depth of a couple of feet of water, and giving a curious illusion of self-luminosity. Upper lip pale green, but darker than lower. Metallic green-gold spot on operculum. Iris greenish silver, speckled with blackish. Fins colourless, or sometimes (especially vertical fins) faintly green; caudal fin occasionally slightly dusky distally. Enteric canal golden green. Vertebrae forming a series of greenish or blackish subrectangular blocks.

Specific name in honour of Mr. Critchley Parker, who collected, and presented to the British Museum, the holotype and about a dozen smaller individuals.

Fig. 3.—*Galaxias (Galaxias) parkeri*, sp. nov. Paratype. Great Lake, Tasmania. (× 1⅛.)

Types. Described from the holotype, in the British Museum (Natural History), London, and from nine paratypes, the variations exhibited by which are recorded throughout in square brackets. A paratype figured (Text-fig. 3). Two paratypes in the Queen Victoria Museum, Launceston (Reg. Nos. PT 950, a-b). Paratypes will be offered to the British Museum (Natural History), London; Australian Institute of Anatomy, Canberra; Australian Museum, Sydney; National Museum, Melbourne; Tasmanian Museum, Hobart; Museum of the Department of Biology, University of Tasmania, Hobart; Museo Argentino de Ciencias Naturales, Buenos Aires.

Locality. Holotype from Great Lake (about off Howell's Neck), Tasmania; caught, on artificial fly, by Mr. Critchley Parker, April, 1934. Paratypes from streams running into the Great Lake at northern end (Little Lake), near Duck Point, and at Reynold's Neck; January, March, April, 1934, February, 1935.

Distribution. In May, 1935, I obtained specimens of this species, collected in ice-covered pools, at Tangled Tarns, in an unmapped region of the Central Plateau, lying on Ritter's track, westward from the Chudleigh Lakes.

Habits. G. (G.) parkeri is common in the Great Lake, and in creeks running into it, its frequency in that locality being at the present time equal to, if not greater than, that of *G. (G.) truttaceus:* these two species appear to be the only forms found in the lake in recent years.

In the streams the smaller individuals occur chiefly near the lake, the larger individuals being met with as a rule from three or four hundred yards to a mile, which is as far as I have as yet had opportunity to trace them, inland. Observations made in February, 1935, showed that, at that time, the younger individuals in the creeks and ditches migrated in large numbers into the lake near sunset, returning in shoals shortly after daybreak, belated examples entering the streams, however, throughout most of the morning.

Specimens at present in captivity exhibit the general habits of the genus, but are characterized by the peculiar attitude of repose noted below. Unless the aquarium has a considerable height above the water-line, it must be kept covered, *e.g.*, with flywire, since, like other species of the genus, the present form is capable of leaping clean out of a tank the walls of which rise five or six inches above the level of the water.

Moderate-sized individuals, fed twice a week, consume a couple of worms at each meal, the hungry fish often struggling vigorously for the food. During the months of May, June, and July, their appetite is not so keen, and they are satisfied with one small meal per week.

When at rest, *G. (G.) parkeri* lies upon the bottom in a peculiar attitude, curiously suggestive of a tetrapod in repose. The whole body is held approximately horizontal, the head being little, if at all, raised; the tail, and frequently the posterior part of the trunk as well, is strongly curved to the right or left; the pectoral and pelvic fins are held motionless, splayed out, their tips resting on the bottom, the preaxial border of the former and the postaxial border of the latter elevated. This attitude, which is generally similar to, though perhaps not identical in detail with, that assumed by some other members of the *weedoni* group, is very different from the resting posture of *G. (G.) truttaceus*, in which species the general level of the body is much higher in front than behind, the head being held well above the bottom; the tail is not, or scarcely, curved; and the pectoral fins are kept in constant motion.

As in other members of the genus, the pectoral fins are commonly furled close to the sides during short bursts of swimming.

Affinities. *G. (G.) parkeri* belongs to the *weedoni* group, from the other members of which it is rather clearly distinguished by its colour-markings. On the whole, it is nearest to *G. (G.) weedoni*. Mr. J. R. Norman, who has compared the holotype with the specimen, 110 mm. in length, forwarded to the British Museum by Johnston in 1880, which Regan (1906) determined and figured (Pl. XI, fig. 1) as *G. weedoni*, observes that the latter differs from the type of *G. parkeri* 'chiefly in the more slender body, rather larger eye, stronger teeth in the lower jaw and on the tongue, and in the coloration'. On comparing the paratypes of *G. (G.) parkeri* with a specimen of *G. (G.) weedoni*, total length 133 mm., standard length 115

mm., in the Australian Museum, Sydney (Aus. Mus. Reg. No. 1. 7431), recorded, in a memorandum by Waite, as being one of the actual examples used by Regan in his revision, I find that these features appear to be constant. The type of *G. (G.) weedoni* has been lost, but Whitley (1929) has made available Johnston's notes on, and sketch of, a specimen, which, judging from the general context and from the dimensions given, appears clearly to be the type—indeed, the figure is so designated by Whitley. This specimen has the head 22 mm. long, and the 'body' (comparison with the figure, which is about 0·93 natural size, shows standard length is meant) 97 mm. The 'more slender body' and 'rather larger eye' of *G. (G.) parkeri*, noted by Mr. Norman as characterizing his material, hold good here. Johnston's sketch seems to depict an individual with rather less marbling of the sides than the example figured by Regan. To these differences may be added the rather more posterior insertion, in moderate-sized or large individuals, of the pelvics in *G. (G.) parkeri* (*G. (G.) weedoni*, it may be recalled, is placed in Regan's *Synopsis of the Species* within the section, 'Origin of ventrals equidistant from tip of snout and base of caudal'), and perhaps the rather longer head, and longer caudal peduncle, relative to the total length, in the present species. Apart from its colour-pattern, *G. (G.) parkeri* differs from *G. (G.) johnstoni* notably in its more numerous anal rays, and its projecting upper jaw; and from *G. (G.) affinis* chiefly in its longer pectoral, longer caudal peduncle, relative to total length and to head, more pointed dorsal and anal, and more depressed snout.

A reference by Johnston to a specimen that may possibly be referable to this species has already been noted in the section of the present paper dealing with *G. (G.) weedoni.*

Parasites. Seven specimens, obtained from streams running into the northern end of the Great Lake, in January, 1934 (from which series one paratype has been selected), are very heavily parasitized by the Opisthorchiid trematode already mentioned as attacking *G. (G.) johnstoni.* The cysts, of which there may be more than a hundred in a square centimetre, commonly give the fish a distinctly verrucose appearance, and may entirely obscure the colour-pattern. It is of interest to observe that of twenty-two individuals of *G. (G.) truttaceus*, collected at the same time, not one exhibits any signs at all of infection.

In another series, comprising five *G. (G.) parkeri* and seven *G. (G.) truttaceus*, collected in streams running into the Great Lake, near Duck Point, in April, 1934, all specimens of the former species are parasitized, though to a decidedly lesser extent than those of the series noted above, while all those of the latter are without apparent signs of infection.

Examples of *G. (G.) parkeri* secured on other occasions are in general wholly free of this parasite.

Under unfavourable conditions in captivity, and presumably also in a state of nature, this species, like most others, is liable to be attacked by a *Saprolegnia*.

History. The holotype and 12 smaller specimens, 42-50 mm. in length, were collected by Mr. Critchley Parker, and forwarded by him to the British Museum, where Mr. J. R. Norman at once recognized the novelty of the form, and drew up a manuscript description of it. Learning, however, that I was working on the Tasmanian Galaxiidae, Mr. Norman very generously handed over his notes to me and forwarded one of the small individuals, with the request that I should describe the species. As I already possessed examples of this form, which I proposed to describe, and as, moreover, I had an opportunity of making full notes on, and a rough colour-sketch of, the holotype prior to its despatch to England, I have accepted with pleasure Mr. Norman's courteous proposal. For the accuracy of the present account, which has been drawn up independently of Mr. Norman's description, I must, of course, assume full responsibility.

Subgenus **Agalaxis,** nov.

Diagnosis. Pelvic fin with 6 rays.

Orthotype. Cobitis zebratus Castelnau = *Galaxias (Agalaxis) zebratus* (Castelnau).

Cobitis zebratus Castelnau, *Mem. Poiss. Afrique Austr.* 1861. p. 56.
Galaxias capensis Steindachner, *Sitzb. Akad. Wien.* CIII. 1894. p. 460. pl. III. fig. 2.

Scope. The subgenus comprises the orthotype and *Galaxias (Agalaxis) punctifer* (Castelnau), 1861.

Distribution. South Africa.

Remarks. The presence of only six rays in the pelvic fin in South African species of *Galaxias* appears to be worthy, particularly in view of the correlation of this character with distribution, of subgeneric recognition.

Agalaxis, an anagram of *Galaxias.*

Genus **Saxilaga,** nov.

Diagnosis. Body elongate. Dorsal fin inserted well back; free of, or obscurely continuous with, caudal ridge; relatively low; with 11-12 simple or mixed rays, all, or some, of which are compressed, clumsy. Anal fin about opposite dorsal; obscurely continuous with caudal ridge; relatively low; with 10-13 rays, similar to those of dorsal. Pelvic fins present; reduced in size; with 6 or 5 rays. Premaxillary and mandibulary teeth uniserial, conical, moderately acute. Entopterygoids toothless. Lingual teeth in two or more series. Eye rather small to small; with free circular lid.

Agrees with *Galaxias*, and differs from *Neochanna*, in possessing pelvic fins: differs from *Galaxias*, and agrees with *Neochanna*, in lacking teeth on the entopterygoid. Apparently an annectant form between these two genera.

Orthotype. *Galaxias cleaveri* Scott.

Saxilaga, an anagram of *Galaxias*.

Subgenus **Saxilaga**, nov.

Diagnosis. Pelvic fin with 6 rays. Lingual teeth biserial.

Orthotype. *Galaxias cleaveri* Scott = *Saxilaga (Saxilaga) cleaveri* (Scott).

Scope. The subgenus comprises the orthotype and *Saxilaga (Saxilaga) anguilliformis*, sp. nov.

Distribution. Tasmania.

Saxilaga (Saxilaga) cleaveri (Scott)

Galaxias cleaveri Scott, *Pap. Roy. Soc. Tasm.* 1933 (1934). p. 41. pl. VI.

Remarks. This Galaxiid, with the pelvics reduced, and with only six rays, with the rounded caudal—the last two characters being strangely reminiscent of the South African *Galaxias (Agalaxias) zebratus*—and with other unusual features, has hitherto proved something of an anomaly; and in describing the species, which is based on a unique holotype, met with in exceptional circumstances, I observed (1934, p. 46): 'While it is with some diffidence that I venture to create, on the strength of a single specimen, a new species in a family so variable as the Galaxiidae, this seems to be, on the available evidence, the only honest course, and is accordingly followed'.

The recent discovery of *S. (S.) anguilliformis* not only justifies the recognition of the present as a genuine and distinct form, but also provides the necessary clue to its affinities, since a re-examination, accompanied by a slight dissection, of the holotype discloses the palate to be edentulous.

In possessing both simple and branched rays in the dorsal and anal fins this species presents a greater resemblance to *Galaxias*, and departs further from *Neochanna*, than do the other species of *Saxilaga*. The branched rays, however, still exhibit something of the peculiar appearance that seems to characterize some at least of the fin-rays in this genus. Of the '22 major rays' noted in the description of the species, 16 only are compressed primary rays, the remainder being merely the enlarged posterior procurrent rays.

Saxilaga (Saxilaga) anguilliformis, sp. nov.

(Text-fig. 4)

B. 9 [9]. D. 12 [12]. A. 13 [12]. P. 14 [12]. V. 6. C. 16 + $\frac{4}{4}$. Gill-rakers on lower limb of anterior arch 8, snout, conical.

Depth of body 7·9 [7·8] in total length, 7·2 [7·2] in standard length. Head 6·3 [6·3] in total length, 5·7 [5·8] in standard length. Snout 4·8 [4·7] in head. Eye 1·2 [1·4] in snout, 2·4 [2·9] in interorbital width, 5·8 [6·5] in head. Depth of caudal peduncle 1·3 [1·3] in its length, 1·2 [1·2] in head. Length of caudal peduncle 1·2 [1·3] in its superior length, 1·1 [1·1] times base of dorsal.

Body slender, anguilliform; greatest width 1·05 [1·05] in greatest depth. Head rather small, scarcely marked off from body; greatest depth 1·2 [1·1] in greatest width; depth at eyes 1·2 [1·2] in width there, the latter dimension being 1·1 [1·1] times length of postorbital portion of head. Eye small. Interorbital region convex. Snout obtuse, little depressed; lower jaw projecting slightly beyond upper. Maxillary extending to slightly behind level of anterior margin of eye. Tubular anterior nostril conspicuous, rather higher than wide; rather nearer anterior margin of upper lip than eye. Simple posterior nostril above, and slightly in advance of, eye; about twice as far from anterior nostril as from orbit.

Head with pores of three sizes.[1] Pores along midlateral line about 48 to level of vent, in general one to each myomere: behind the level of the vent, where there are about 25 myomeres, the pores are not countable with certainty.

Lingual teeth biserial, rather large, fairly acute. No pterygoidal teeth. Premaxillary teeth moderate, conical, moderately acute, subequal. Mandibulary teeth moderate, conical, moderately acute; several more or less distinctly enlarged lateral canines.

Dorsal fin long, low; all rays simple; base 1·4 [1·3] in head, less than caudal peduncle, subequal to depth of body; vertical height 3·2 [3·3] in head, less than combined eye and snout; longest (6th [6th]) ray 2·4 [2·3] in head, equal to interorbital width; distance from its origin to base of caudal 4·0 [4·0] in total length, 3·7 [3·7] in standard length; laid back, reaches caudal ridge; a thick fleshy sheath, rising anteriorly, where it is highest, to tip of second ray, envelops basal half of fin.

Anal fin slightly longer than, subequal in height to, dorsal; all rays simple; base 1·3 [1·2] in head; subequal to caudal peduncle; vertical height 3·2 [3·3] in head; longest (6th [6th]) ray 2·1 [2·6] in head; originating behind origin of dorsal by 0·1 [0·1] of base of latter; terminating behind base of dorsal by 0·2 [0·2] of latter; laid back, fails to attain base of caudal by a distance subequal to depth of caudal peduncle; with fleshy basal pad, similar to that of dorsal; obscurely joined by thick membrane to caudal ridge.

Pectoral fin small, rounded; three or four of the median rays feebly cleft for about 1/10 of their length, the rest simple; longest

[1] It is highly probable that, examined by the methods used with such striking success by Sanzo (1911), de Buen (1923), and others in the investigation of the topography of the openings of the mucus-canals and goniopores in the Gobiidae, these cephalic pores would prove of diagnostic value.

(9th [6th]) ray 1·8 [2·2] in head; extending 0·3 [0·2] of distance from its origin to origin of pelvic.

Pelvic fin small; longest (3rd [3rd]) ray 2·8 [2·9] in. head, 16·5 [18·3] in total length; originating midway between caudal base and eye; length to its origin 2·2 [2·1] in total length, 1·9 [1·9] in standard length; extending 0·3 [0·2] of distance from its origin to origin of anal.

Caudal fin truncate rounded [feebly emarginate]; small, length 1·7 [2·0] in head, subequal to depth of caudal peduncle. Procurrent rays, except the posterior three or four, deeply buried in fleshy caudal ridge.

Total length 91 mm. [82 mm.]; standard length 82·5 mm. [75·5 mm.].

Ground colour (in formalin) greenish grey, paler beneath. Sides of body heavily barred and blotched with dark greenish brown; about eight or ten fairly regular forwardly convex bars, once to twice as wide as their interspaces, in advance of pelvics, behind which the markings, though in some cases still traceable as bars, tend in general to break up into blotches and reticulations of irregular form and varying size. No special shoulder-bar. Dorsal surface with numerous dark blotches, and vermiculate markings. Ventral surface macroscopically immaculate, minutely and sparsely punctulated with dark green. Head in general concolorous with body, heavily spotted dorsally, and, except for portion of cheek, laterally, with dark greenish brown; a triangular region, whose base embraces the eyes and whose apex about reaches the occiput, decidedly darker than rest of head; lips concolorous with lower part of operculum, which is greenish slate; ventral surface abundantly punctulated with greenish and greenish brown. Iris dark blue, with a lighter semilunar streak overarching pupil; no suborbital dark streak. Dorsal and anal fins with membrane hyaline, with microscopic brownish spots; lateral borders of rays dark; fleshy basal sheath greenish, with a few dark spots and numerous punctulations. Pectoral and pelvic fins virtually colourless, with scattered punctulations, most numerous basally; tips of rays of former dusky. Caudal fin greenish hyaline, the membrane marked with microscopic greenish brown spots; at base an irregular arc of conspicuous dark spots, with indications of the existence of two further, more external, concentric arcs of brownish. Caudal ridges each with eight or ten well-marked dark spots.

Specific name in allusion to the general eel-like facies.

Types. Described and figured from the holotype (Text-fig. 4) in the Queen Victoria Museum, Launceston (Reg. No. HT 951), with variations exhibited by a paratype, which will be offered to the British Museum (Natural History), London, recorded throughout in square brackets. The paratype lacks the left ventral fin, the loss having apparently occurred during life.

Locality. Creek, known locally as Cox's Creek, running into the Inglis River at Wynyard, North-Western Tasmania. Caught, on hook and line, by Master N. Blackwell, where the creek runs through Dead Horse Gully; forwarded by Mr. James Harrison, 11th December, 1934. During the course of a short visit to the locality by the writer, on 27th December, on which occasion no further specimens of the present form were secured, it was observed that the stream was inhabited abundantly by *Galaxias (Galaxias) attenuatus*, and less abundantly by *G. (G.) truttaceus.*

Habits. The general structure strongly suggests the fish is adapted to live in muddy situations.

Major R. E. Smith, Launceston, informs me that a Galaxiid that he identifies with the present form occurs in swamps near the mouths of the Forth River and the Clayton Rivulet, being known locally as 'mud-trout'. While it is not unlikely that this mud-trout may be *S. (S.) cleaveri* instead of, or in company with, *S. (S.) anguilliformis*, there is good reason to believe it to be, at any rate, some member

Fig. 4.—*Saxilaga (Saxilaga) anguilliformis*, sp. nov. Holotype. Cox's Creek, Tasmania. Natural size.

of the present genus. Major Smith states: 'In habits it differs very much [*i.e.*, from *G. (G.) attenuatus* and *G. (G.) truttaceus*]. It is generally found when drains are being cleaned out, and seems to be actually dug out of the mud. In swamps and drains that have completely lost all trace of water they can be found in damp mud. I have often got them by turning over logs and stones where they are to be found in mud. Like an eel they will live a long time out of water'.

Affinities. S. (S.) anguilliformis presents, on the whole, a more neochannoid facies than *S. (S.) cleaveri.* It differs from the latter species chiefly in having the dorsal and anal rays more numerous, and all simple, instead of mixed; markedly more forwardly placed anal, the $\frac{A - D}{(d - D) + (a - A)} \times 100$ value being 4·5-4·9, as against 22·2 for *S. (S.) cleaveri;* larger eye; shorter snout; and perhaps also in the rather stouter body, and rather shorter head.

Remarks. A burrowing Galaxiid has been noted from Tasmania by Hall (1901, p. 65). This, however, was stated to be 'clearly a *Galaxias*'. Hall's specimen, which has never been properly determined, may possibly be referable, if it is indeed a *Galaxias*, to *G. (G.) atkinsoni* Johnston, generally regarded as a synonym of *G. (G.)*

weedoni Johnston. Verbal reports of a burrowing Galaxiid in Tasmania have previously been noted by the present writer (1934, p. 43).

Hall also observes: 'Fish are reported as being occasionally dug up in the "button-grass country" on the west coast of the island, and are stated by a miner to have no eyes, though otherwise similar'. For some time past I have been endeavouring, so far without success, to obtain specimens of a blind, or almost blind, Galaxiid said to occur near Marrawah. It seems not unlikely that these reports relate to *Saxilaga;* though the possibility of *Neochanna,* or of some quite unknown form, occurring in Tasmania is not altogether to be discounted.

Subgenus **Lixagasa,** nov.

Diagnosis. Pelvic fin with 5 rays. Lingual teeth in more than two series.

Orthotype. Galaxias burrowsius Phillipps = *Saxilaga (Lixagasa) burrowsius* (Phillipps).

Galaxias burrowsius Phillips, *Trans. N.Z. Inst.* 56. 1926. p. 531. pl. 88 (issued separately 26th April, 1926).

Scope. The subgenus comprises only the orthotype.

Distribution. New Zealand.

Lixagasa, an anagram of *Galaxias.*

Remarks. Phillipps (1926 (b), p. 532) observes of the subgenotype that it is 'undoubtedly a degenerate form of *Galaxias,* and to some extent a connecting link between *Galaxias* and *Neochanna*'. He notes that the two type-specimens, from West Oxford, in the South Island, packed in damp earth, survived a journey by post of over thirty hours; and gives an interesting account of the aestivation of this species in coconut-shaped holes in the ground.

Subfamily *PARAGALAXIINAE,* nov.

Diagnosis. Dorsal fin inserted well back, about over pelvic fins, the length to origin of dorsal being less than one-half total length. Pelvic fins present. Premaxillary and mandibulary teeth biserial or uniserial. Entopterygoid toothed. Lingual teeth in two series. [Vertebrae less than 50 in *P. shannonensis.*]

Type-Genus. Paragalaxias Scott, 1935.

Scope. The subfamily comprises the genus *Paragalaxias* and *Galaxias dissimilis* Regan.

Distribution. Tasmania. New South Wales(?).

Remarks. Judged solely on its external features, *Galaxias dissimilis* Regan, a figure of which has been made available by Whitley (1933), would appear to be congeneric with *Paragalaxias shannonensis;* and I have already pointed out (1935, p. 45) that its status could be satisfactorily determined only as the result of a re-examina-

tion of the dentition. At my request, Mr. J. R. Norman, of the British Museum, has very kindly made an examination of the unique holotype of the species, and now informs me (*in lit.*) that the teeth in the jaws are in a single series. Mr. Whitley's proposed generic name, *Querigalaxias*, mentioned earlier, will be available for the species when formally completed.

Genus **Paragalaxias** Scott, 1935.

Diagnosis. Body moderately elongate. Dorsal fin inserted well forward; free of caudal; relatively high; with 12-15 rays, which are mixed, or simple. Anal fin inserted well back, originating far behind dorsal, in normal Galaxiid position: free of caudal; moderately high; with about 9 rays, which are mixed, or simple. Pelvic fins present; with 6 rays. Premaxillary and mandibulary teeth biserial or uniserial, subconical, pointed. Entopterygoids each with a single series of teeth. Lingual teeth biserial. Eye small; with free circular lid. Vertebrae 44 (in *P. shannonensis*).

Orthotype. Paragalaxias shannonensis Scott.

Paragalaxias shannonensis Scott, *Pap. Roy. Soc. Tasm.* 1934 (1935). p. 41. pl. III. and text-figs. 1-2.

Scope. The genus includes only the orthotype.

Distribution. Tasmania.

Type-locality. Shannon River, Tasmania.

Summary

1. The scope and interest of the Tasmanian Galaxiid fauna are noted, and some general remarks on taxonomy are made.

2. Two new subfamilies of Galaxiidae, namely, Galaxiinae and Paragalaxiinae, are instituted.

3. Two new subgenera of *Galaxias* Cuvier, namely, *Galaxias* and *Agalaxis*, are proposed.

4. A new genus, *Saxilaga*, with two subgenera, *Saxilaga* and *Lixagasa*, is diagnosed.

5. A key to the subfamilies, genera, and subgenera dealt with is provided.

6. Previously described Tasmanian species are listed, and, where necessary, commented upon: *Galaxias rostratus* Klunzinger is shown not to be Tasmanian; *G. cleaveri* Scott is referred to *Saxilaga*, nov.; the type-locality of *G. truttaceus* (Cuvier) is fixed.

7. New species described, and figured, are: *Galaxias (Galaxias) johnstoni, Galaxias (Galaxias) scopus, Galaxias (Galaxias) parkeri*, and *Saxilaga (Saxilaga) anguilliformis.*

The present communication is the second of a series, the preparation of which has been facilitated by the granting of a Research Scholarship by the University of Tasmania. It is desired here to

repeat the acknowledgements made in a previous paper (1935) of assistance received from the Board of Studies, and from Mr. V. V. Hickman, B.A., B.Sc., Ralston Lecturer in Biology. For the opportunity of examining the material in the Australian Museum, Sydney, noted in the text, thanks are tendered to the Director, Dr. Charles Anderson.

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Observations on Some Tasmanian Fishes

Part III

By

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(Read 30th September, 1935)

The present paper, the precise scope of which is summarized in the concluding paragraph, follows the general plan of previous communications under the same title (1934, 1935).

Registration numbers are those of the Queen Victoria Museum, Launceston.

Family HAPLOCHITONIDAE

Genus **Lovettia** McCulloch, 1915

Lovettia sealii (Johnston)

Haplochiton sealii Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883). p. 128.
Lovettia sealii McCulloch, *Proc. Linn. Soc. N.S.W.* xl. 2. 1915. p. 259. pl. XXXV. fig. 2.

Whitebait-Constituent. Johnston has noted the appearance of this species in large shoals in the Derwent, near New Norfolk, in October and November, the females then being full of mature ova.

In two samples of 'whitebait', each containing 200 individuals, purchased in Launceston fish-shops, the first sample, consisting of material from the Tamar River, on 17th September, 1934, the second, consisting of material from the Mersey River, near Latrobe, on 14th September, 1935, this species was found in each case to be easily the dominant constituent. First sample: 192 *L. sealii* (total length 41·5-56 mm.); 7 *Galaxias attenuatus* (44-52 mm.); 1 *Galaxias sp.*, probably *G. truttaceus* (58 mm.). Second sample: 172 *L. sealii* (55-65 mm.); 23 *Galaxias attenuatus* (38·5-52 mm.); 5 *Galaxias sp.*, probably *G. truttaceus* (49-65 mm.). As an indication of its abundance, it may be noted that whitebait is sold in Launceston at the rate of between two hundred and three hundred fish for a penny.

The results of these analyses are rather surprising, as it is generally believed, in view of the statements of Johnston (1883, p. 62) on the subject, that the Tasmanian 'whitebait' consists essentially

of *Retropinna tasmanica* McCulloch, accompanied in varying numbers by *Galaxias attenuatus* (Jenyns) and *Atherina spp.* It is evident that either the composition of the shoals is subject to remarkable variation, or else, more probably, at least two distinct migrations are being confused.

An examination of numerous examples confirms the statement by McCulloch (1915, p. 260) that the maxillary extends only to the level of the anterior fourth or third, and not, as described by Johnston, to below the middle, of the eye.

Family ECHELIDAE

Genus **Muraenichthys** Bleeker, 1865

Muraenichthys australis Macleay

Muraenichthys australis Macleay, *Proc. Linn. Soc. N.S.W.* VI. 2. 1881. p. 272.
Scolenchelys australis Ogilby, *Proc. Linn. Soc. N.S.W.* XXII. 2. 1897. p. 246.

Record. A specimen from Northern Tasmania in the Museum collection (Reg. No. FR 947) appears clearly to be referable to this species. The origin of the dorsal is shortly behind that of the anal, as noted by McCulloch (1911, p. 20) in his re-examination of the holotype in the Macleay Museum, and not over the vent, as stated in Macleay's original description.

Proportions. The principal proportions of the specimen are recorded for comparison with those of the holotype as given by McCulloch. Depth of body behind gill opening (5·8 mm.) 3·9, behind vent (5·5) 4·1, in head (22·5). Head 12·1 in total length (272), 4·1 in trunk (91·5). Eye (1·2) 3·5 in snout (4·25), which is 5·0 in head. Mouth-cleft (8) 2·6 in head. Length to vent (114) 1·39 in tail (158). Length to origin of anal (116) 1·01 in length to origin of dorsal (117).

Remarks. First record for Tasmania. The species has previously been recorded only from New South Wales.

Genus **Ophiclinus** Castelnau, 1872

Ophiclinus greeni, sp. nov.

(Text-fig. 1)

D. xlix, 1 [xlix, 1]. A. iii, 31 [iii, 31-32]. P. 11 (left fin), 12 (right fin) [11-12]. V. 2 [2]. C. 13 + $\frac{1}{1}$ [13 + $\frac{1}{1}$].

Depth 7·6 [7·1-8·2] in total length, 6·9 [6·4-7·5] in standard length; depth at level of first anal ray 7·8 [7·7-8·9] in total length, 7·1 [6·9-8·1] in standard length. Head 5·7 [4·9-5·4] in total length, 5·2 [4·4-5·0] in standard length. Eye 5·5 [5·3-6·1] in head, 1·5 [1·2-1·4] in snout, 1·2 [1·1] times interocular distance. Head and trunk 1·2 [1·1-1·2] in tail without caudal fin.

Body elongate, compressed, covered with small non-imbricating scales, somewhat more closely set posteriorly (not shown in figure). Head subconical; naked, as also is nape. Eye moderate, not cutting superior profile; interorbital space convex. Lower jaw projecting slightly beyond upper; maxillary extending to [or slightly beyond] level of middle of eye. Anterior nostril tubular, higher than wide, surmounted posteriorly by a short blunt tentacle; inserted at about the position of two (or ten) o'clock relative to the eye, rather nearer upper lip than orbit; its distance from its fellow 1·8 [2·0] in length of snout. Posterior nostril a simple opening close to orbit, at about the position of one o'clock.

Lateral teeth in upper jaw small, uniserial or biserial, the row or rows widening anteriorly to form a very broad patch, among which are larger teeth. Mandibulary teeth in a fairly broad band anteriorly, becoming uniserial laterally. Vomerine teeth acute, fairly large, in a uniserial or biserial proconvex arc.

Fairly large pores on dorsal surface of snout, between eyes, encircling eye, fringing preoperculum, on mandible, on superolateral and dorsal surfaces of postorbital portion of head. Lateral line short, comprising about 15 pores; very slightly arched, its origin and termination at about the same horizontal level; originating just above base of opercular flap, at level of 2nd dorsal spine; terminating at about level of 10th dorsal spine.

Dorsal fin originating about midway between levels of preopercular and opercular margins; length to its origin 1·1 [1·1] in head; joined to proximal third of caudal; 1st spine 5·2 [5·7-6·0], 25th spine 3·1 [3·6-3·9], the single ray 2·8 [3·0-3·4], in head. Anal fin originating below 20th [19th-20th] dorsal spine; length to its origin 2·2 [2·1-2·2] in standard length; joined to proximal third of caudal; 2nd spine 6·0 [7·2-·7·7], 16th ray 2·9 [3·0-3·7], in head. Pectoral fin rounded; all rays simple; extending 0·5 [0·4-0·5] of distance between its origin and vent; longest (6th) [6th-7th] ray 1·7 [1·7-1·9] in head. Pelvic fins contiguous basally; length to their origin 1·2 [1·2-1·3] in head; longer (inner and hinder) ray 1·4 [1·6-1·8] in head. Caudal fin truncate, feebly rounded; all rays simple; 1·9 [2·0-2·1] in head, 9·8 [8·8-10·6] in standard length.

General colour dark brown, approaching black, above, greyish brown, or pale brown, below. On the body the essential features of the colour-pattern are: first, a broad dark region bounded inferiorly by a line running from a little below the upper angle of the operculum to near the middle of the caudal base; secondly, below this, a slighter broader region, which, in advance of the vent, is much lighter in colour than, and very sharply delimited from, the first region, but which, behind the vent, progressively darkens, and ultimately becomes more or less assimilated with the upper region, there always being left, however, several small islands of light ground colour between the partial fusion of the two regions posteriorly. The

intensity and extent of the darkish region above the anal base vary considerably. In the larger paratype a narrow yellowish streak immediately underlies the dark upper region of the sides, and the distal islands are a discrete backward extension of this, rather than of the brownish of the general lower region: a similar state of affairs obtains, in a much less marked degree, in the holotype. In the anterior half or third of its length the dorsal base is narrowly bordered on each side with yellowish; further back there appear a few discontinuous indications of the extension caudad of this stripe. A longitudinal band, either wholly blackish or dark brown margined with blackish, runs from tip of snout, just embracing eye, to operculum, where its inferior margin becomes confluent, without change of direction, with the lower border of dark region of sides of body, and its superior margin rises to join the upper border of the same region where it bounds the yellowish streak at base of dorsal. Anteriorly this band embraces the upper third of both upper and lower lips, which, being elsewhere greenish, immaculate, are thus

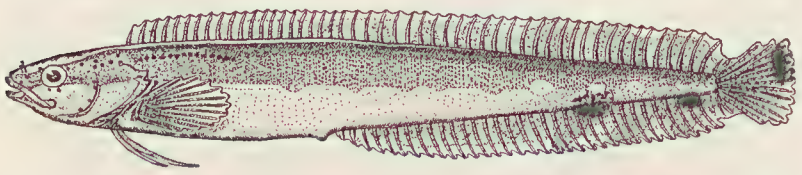

Fig. 1.—*Ophiclinus greeni*, sp. nov. Holotype. Low Head, Tasmania. Total length 44·6 mm. [The small non-imbricate scales are not shown.]

conspicuously bicolor. Dorsal surface of head brownish; ventral and lateral aspects concolorous with corresponding light-coloured aspects of body, and, like them, minutely punctulate with brownish. Dorsal fin brownish, with narrow distal band of white; the dark brown of the sides continued up on to the fin in a variable number of blotches, most extensive, most closely set, and darkest posteriorly. Anal fin similar to dorsal, but with rather wider white border. Pectoral fin white. Pelvic fin greyish; in one paratype pale pinkish brown.

Life-colours, as noted by collector. 'Dorsal fin light with dark continuations of body-colour. Lower portion [of body] light pinkish colour. Pectoral fins tipped with pink.'

Total length 44·6 mm. [34·3-49·8 mm.]; standard length 40·5 mm. [31·9-45·5 mm.].

Specific name in honour of Mr. G. R. F. Green, collector of the specimens described, whose interest in rock-pool fauna has enriched the Museum collections with much interesting ichthyological and invertebrate material.

Types. Described and figured from the holotype (Text-fig. 1) and from two paratypes, the numerical characters of the latter being

recorded throughout in square brackets. Holotype in the Queen Victoria Museum, Launceston (Reg. No. HT 805). Paratypes will be offered to the British Museum (Natural History), London, and Australian Institute of Anatomy, Canberra.

Locality. Lady Lucy Beach, Low Head, Northern Tasmania; 17th January, 1934, and 3rd June, 1934.

Affinities. *Ophiclinus greeni* belongs to the group of species (*O. gracilis* Waite, and *O. gabrieli* Waite) comprised under the heading 'Vomerine teeth pointed, forming an angular row or series' in the key by McCulloch and Waite (1918, p. 55). It may readily be distinguished from *O. microchirus* (Herzenstein) and *O. homocanthus* (Herzenstein), which are not noted in the key by McCulloch and Waite, and for copies of the descriptions of which I am indebted to the courtesy of Mr. G. P. Whitley, Ichthyologist, Australian Museum, Sydney, by its decidedly fewer dorsal and anal rays (*O. microchirus* has D. 90, A. 56; *O. homocanthus*, D. 56-60, A. 40-42).

It finds its nearest ally in *O. gracilis* Waite, which in general appearance and coloration it very closely approaches, and from which it is chiefly distinguished by the following characters: consistently greater number of dorsal spines and anal rays; rather fewer pectoral rays; origin of anal below about 20th, instead of 17th, dorsal spine; lateral line nearly straight, not, or scarcely, continued obliquely downwards posteriorly. From *O. gabrieli* Waite, which it approaches in the formulae of the vertical fins, and in the course of the lateral line, it is readily separable by the more anterior origin, and greater evenness of height anteriorly, of the dorsal fin; larger pectoral; less rounded caudal; coloration. In the legend to Waite's plate (1906, pl. XXXVI) accompanying the original descriptions of *O. gracilis* and *O. gabrieli* the names of the two species are transposed.

Remarks. First record of the family Ophiclinidae from Tasmania.

Family OPHIDIIDAE

Genus Genypterus Philippi, 1857

Genypterus blacodes (Bloch and Schneider)

Ophidium blacodes Bloch and Schneider, *Syst. Ichth.* 1801. p. 484.
Genypterus blacodes McCulloch, *Aust. Mus. Mem.* V. III. 1929. p. 357 (references and synonymy).

Variation. A specimen, 402 mm. in total length, caught near George Town, on or about 20th March, 1934 (Reg. No. 832), exhibits an interesting, and (at least in Tasmanian examples) apparently rare, variation in colour-pattern. Instead of being whitish, immaculate, the preanal ventral region is somewhat bluish green, faintly tinged with pale brown, and is conspicuously mottled with the dark vandyck brown of the ordinary lateral blotches. The mottlings, of which there are about 150, are longest longitudinally: they vary in

form from elliptical to linear, and in size from about 2 mm. to about 15 mm. The chin, which is normally white, and immaculate, save that a small patch of punctulations is often present at about the level of the hinder end of the maxillary, is here minutely but thickly dotted throughout with brown. The specimen exhibits no deviation from the normal in structure or proportions.

Distribution. This appears to be the common species of Northern Tasmania, practically all the locally obtained ling retailed in Launceston fish-shops being this form. On the other hand, supplies received in Launceston from Strahan consist almost exclusively of *Genypterus microstomus* Regan.

Family GOBIESOCIDAE

Remarks. In spite of its small size, the Australian group of Gobiesocidae has been dogged by confusion, which has followed it not only along the seemingly inescapable highway of nomenclatural misapprehension, but also even into the byways of trivial error in orthography and the notation of illustrations. Whitley (1931) has recently defined more clearly the relationships of several species, both to one another, and to extralimital forms. The whole group, however, appears to be in need of anatomical and osteological revision: accordingly, in the arbitrary key given below generic affinities as customarily recognised are expressly disregarded, and emphasis is placed on characters that, though of minor taxonomic significance, afford practical criteria for ready determination.

Reduced to the simplest terms by the omission of purely formal and derivative references, the histories of the six Australian members of the family, considered in historical sequence, are as follow:

(*a*) *Aspasmogaster tasmaniensis* (Günther). Original description (1861, p. 507), as logotype of *Crepidogaster*, based on a single individual, 26 lines in total length, presented to the British Museum by Ronald Gunn; not figured. McCulloch (1922, p. 122) notes a record by Kner (1867, p. 277) from Sydney, but regards it as an error, and in the Check-List (1929, p. 359) gives New South Wales as a queried locality. Waite, who had already (1906, p. 201) discussed, under the generic name *Crepidogaster*, the species next to be mentioned, later (1907, p. 315) called attention to the fact that *Crepidogaster* Günther, 1861, was preoccupied by *Crepidogaster* Boheman, 1848 (Coleoptera), and put forward the *nom nov.*, *Aspasmogaster*—afterwards, *fide* McCulloch (1929, p. 359), spelt *Aspasmagaster* by Jordon in *Genera of Fishes*. Included by Waite (1923) in his last South Australian catalogue. The species, which is not the subject of recent description in literature available to me, is redescribed and figured below.

(*b*) *Aspasmogaster spatula* (Günther). Original description (1861, p. 508) based on a single specimen, 21 lines in total length, from Gages Road, Swan River, Western Australia; not figured. Described in detail (p. 201), and figured by Waite (1906), who gives Victorian records. Waite's text correctly refers to his pl. XXXVI, fig. 4, but the legend to the plate gives fig. 2 as *A. spatula*, fig. 2 actually being *V. cardinalis*. Generic history as in (*a*).

(*c*) *Volgiolus cardinalis* (Ramsay). Günther (1861, p. 506) established *Diplocrepis*, with *Lepadogaster puniceus* Richardson, from New Zealand, as haplotype, and Ramsay's Gobiesocid from near George Town, Tasmania, originally described (1882, p. 148) as *Gobiesox cardinalis*, has been referred to Günther's genus by Waite and Australian authors generally. Detailed description (p. 204) and figure (pl. XXXVI, fig. 2) by Waite (1906), based on three specimens from near Launceston, and three from Ulverstone, forwarded from this Museum in 1903. Waite's text cites pl. XXXVI, fig. 1, but fig. 1 is a Symbranchid; the legend to the plate, on the other hand, gives *V. cardinalis* as fig. 4, but actually fig. 4 is *A. spatula*, the figure of *V. cardinalis* being that numbered 2 on the plate. Included in synopsis of species of *Diplocrepis* by Waite (1906, p. 205). Whitley (1931, p. 325) considers that the Australian species hitherto relegated to *Diplocrepis* are not congeneric with *Lepadogaster puniceus* Richardson, and has proposed *Parvicrepis* for *D. parvipinnis* Waite, with *Volgiolus* as a subgenus having as orthotype *D. costatus* Ogilby, and apparently including also *G. cardinalis* Ramsay. More recently (1935, p. 292), in giving illustrations of the adhesive apparatus, he elevates the two species last mentioned to separate generic status as *Volgiolus costatus* and *V. cardinalis*, respectively. Life-colours of present species, apparently hitherto unrecorded, described below.

(*d*) *Volgiolus costatus* (Ogilby). The first reference to the species (1885, p. iii) is a *nom. nud.*, the description (1885, p. 270) being made available some five weeks later; not figured. Type-locality: Shark Reef, Port Jackson, N.S.W. Since recorded, *fide* McCulloch (1929, p. 360), from South Australia, Victoria, Lord Howe Island, New Caledonia. Figure (fish) by Waite (1904, pl. XXIV, fig. 1); inclusion in synopsis of species of *Diplocrepis* by Waite (1906, p. 205); variation in radial formulae by McCulloch and Waite (1918, p. 66); generic history as in (*c*); figure (ventral aspect of head and trunk) by Whitley (1935, p. 292).

(*e*) *Parvicrepis parvipinnis* (Waite). Original description (1906, p. 202), with figure (pl. XXXVI, fig. 3), and inclusion in synopsis of species of *Diplocrepis* (p. 205); New South Wales. For generic history, see (*c*).

(*f*) *Lepadichthys frenatus* Waite. Originally described (1904, p. 180) and figured (pl. XXIV, fig. 2) from two specimens from Lord Howe Island; since recorded also from Queensland.

Key to the Australian Gobiesocidae.

A. Dorsal fin not connected by membrane with base of caudal fin

B. Horizontal distance between termination of dorsal and base of median caudal rays much greater than (nearly twice) total base of dorsal .... *Parvicrepis parvipinnis*

BB. Horizontal distance between termination of dorsal and base of median caudal rays much less than (about one-third of) total base of dorsal:

C. Vent much nearer to anal fin than to adhesive apparatus. Anal origin slightly behind dorsal origin .... *Volgiolus costatus*

CC. Vent rather nearer to adhesive apparatus than to anal fin. Anal origin about below middle of dorsal base .... *Volgiolus cardinalis*

BBB. Horizontal distance between termination of dorsal and base of median caudal rays rather less than (about two-thirds of) total base of dorsal .... *Aspasmogaster spatula*

AA. Dorsal fin connected by membrane with base of caudal fin

D. Dorsal with about 16 rays; its base about equal to length of head. Anal joined by membrane to caudal .... *Lepadichthys frenatus*

DD. Dorsal with 8-10 rays; its base about half length of head. Anal not joined by membranes to caudal .... *Aspasmogaster tasmaniensis*

Genus **Aspasmogaster** Waite, 1907

Aspasmogaster tasmaniensis (Günther)

(Text-fig. 2)

Crepidogaster tasmaniensis Günther, *Cat. Fish. Brit. Mus.* III. 1861, p. 507.
Aspasmogaster tasmaniensis Waite, *Rec. Aust. Mus.* VI. 4. 1907. p. 315.

B. 5. D. 8-10. A. 7-9. V. I, 4. P. 23-24. C. 12 $+\frac{c.\ 2\ -\ 3}{c.\ 3\ -\ 4}$.

Length of head 2·9-3·1, width of head 4·1-4·4, depth of body 6·2-8·4, width of body 5·6-6·5, in total length. Snout 3·3-4·1 in head, 10·0-12·0 in total length. Eye 4·1-5·1 in head, 1·1-1·3 in interorbital width.

Body subcylindrical anteriorly, somewhat compressed posteriorly. Head much depressed; moderately broad; its width subequal to distance from anterior margin of eye to origin of pectoral. Snout narrow, beak-like, greatly depressed, its tip (excluding upper lip) about on a horizontal level with inferior margin of pupil, its dorsal surface concave. Nearly half the dorsal profile in advance of eye formed by the large, completely reflexed upper lip. Upper jaw projecting beyond lower. Lower lips meeting at symphysis, immediately behind which they are markedly inflated inwardly and downwardly. Mouth extending to below anterior $\frac{1}{5}$ or $\frac{1}{3}$ of eye. Teeth in upper

jaw small, villiform; in a large patch of 5 or 6 rows in front, in one or two series behind. Teeth in lower jaw similarly disposed, but rather larger, especially laterally. Anterior nostril tubular; slightly in advance of orbit, at about level of middle of eye; its distance from its fellow subequal to its distance behind tip of snout, excluding upper lip; about as wide as high, surmounted by a bluntly bilobed process, whose length slightly exceeds distance between anterior and posterior nostril. Posterior nostril tubular; placed hard against eye, at position (left aspect) of ten o'clock; about as wide as high. Eye large, subcircular, tumid, cutting dorsal profile. Interorbital space flat, or slightly concave. No subcutaneous spine on operculum or preoperculum. Gill-membranes united across isthmus, shortly in advance of anterior adhesive disk.

Dorsal fin rather long and low; inserted far back, its last ray joined to caudal by membrane; length to its origin 1·5 in total length, 1·3-1·4 in standard length; base 1·5-1·6 in head, subequal to distance between anterior margin of sucker and tip of lower lip; median rays subequal to snout. Anal fin similar in form to, but shorter than, dorsal; originating about below 2nd dorsal ray; terminating below interspace between origin of last dorsal ray and point of attachment of membrane joining it to caudal; last ray obscurely joined to caudal peduncle by membrane; base 1·2 in that of dorsal. Pectoral fin broad, rounded; its longest (about 10th) ray 2·6-2·9 in head; its length subequal to that of posterior adhesive disk, at, or just beyond, the level of which the fin terminates. Pelvics attached to 16th-17th pectoral ray; their crenulated common anterior border free, extending to within about an eye-diameter of posterior margin of eye; their free tips extending to level of middle of posterior sucker, or slightly beyond. Caudal fin moderate, rounded; length 2·3 in head, rather less than anal base.

Anterior adhesive apparatus about as wide as body at level of pectoral origin; its inner gelatinous region subcircular, the slightly truncated posterior margin just overlapped by free anterior border of second sucker. Posterior adhesive apparatus transversely elliptical; its width, which is almost as great as that of the body at this point, nearly one and one-third times its length, which is subequal to its distance from vent, or about half width of head; its inner gelatinous region comprising an anterior subrectangular portion followed by about three-fourths of an ellipse, the transverse major axis of which is rather less than diameter of gelatinous disk of first sucker; distance of free posterior margin of whole apparatus from vent 1·3-1·6 times distance of vent from origin of anal fin.

The colour in life was noted by the collector, Mr. G. R. F. Green, as 'Dark green with brown markings when found; but when placed in a white net turned light green'. Examined shortly after their preservation in formalin, the specimens exhibited a striking colour-pattern, comprising some fourteen vertical dark bars, which, except

for the bar overlapped by the adpressed pectoral, which is twice as wide as its neighbours, are subequal in width to the interspaces of lighter ground colour. After long preservation in formalin they become a uniform dingy, very pale, pinkish yellow.

Material examined. Described from three specimens, 53, 53, 36 mm. in total length, or 46, 46, 30·75 mm., respectively, in standard length. (Reg. Nos. 903 *a-c.*) One of the larger individuals figured (Text-fig. 2).

Locality. In rocky pools, Lady Lucy Beach, Low Head, Northern Tasmania; Mr. G. R. F. Green; 4th March, 1934.

Remarks. The specimens agree reasonably well with Günther's description, the most important point of divergence being that Günther observes, 'caudal fin quite free from dorsal and anal', whereas in the present examples the dorsal is connected by membrane with the base of the caudal. The connection is, however, barely made, being decidedly less extensive, for instance, than that in *Lepadichthys frenatus* Waite (in which form the anal also is joined to the caudal):

Fig. 2.—*Aspasmogaster tasmaniensis* (Günther). A specimen from Low Head, Tasmania. (× 2.)

it seems probable that the connecting membrane could easily be destroyed as the result of a slight injury. The remaining characters of the present examples, including the peculiar narrow snout, are so generally conformable to the description of *A. tasmaniensis* as to leave little doubt the specimens are really referable to this species.

Affinities. A. tasmaniensis is distinguishable at sight from the only other Australian member of the genus, *A. spatula* Günther, recorded from Victoria and Western Australia, by the much more posterior insertion of, longer bases of, and inequality between, its dorsal and anal fins, and by its narrow snout. The produced snout and the union of dorsal and caudal serve also to distinguish the present form from the two New Zealand species—*A. hectoris* (Günther), type-locality southern shore of Cook's Strait, having the 'caudal peduncle slender, longer than the caudal fin' (1876, p. 396), and *A. simus* (Hutton), described from Lyttleton Harbour and Chatham Islands, having the 'distance from the end of the dorsal, or anal, to the caudal very short, about one-fifth of the length of the caudal, or one-third of the least depth of the tail' (1896, p. 316).

Genus **Volgiolus** Whitley, 1935

Volgiolus cardinalis (Ramsay)

Gobiesox cardinalis Ramsay, *Proc. Linn. Soc. N.S.W.* VII. 2. 1882. p. 148.
Volgiolus cardinalis Whitley, *Aust. Mus. Mag.* V. 9. 1935. p. 292 (text-fig.).

Occurrence. At George Town and Low Head—the type-locality is 'near George Town'—this species is quite a common constituent of the intertidal rock-pool fauna. I have met with it also at Ulverstone—from which locality, as mentioned above, specimens examined by Waite were obtained—but have not noted it as being at all common there.

Colour. While the specific name *cardinalis* clearly indicates the colour of Ramsay's material, Waite says of his specimens, 'In fluid all examples are uniformly yellow'. In my experience the colour depends on the medium of preservation. Specimens in alcohol become bright red (occasionally slightly mottled with yellow) everywhere save on the preanal ventral surface, which turns yellow, the fins assuming the colour of the body in the vicinity: examples preserved in formalin become throughout, including fins, a dull pale yellow, occasionally exhibiting a faint purplish tinge.

Waite (1906) observed that the life-colours are not known, a state of ignorance apparently still unremedied. Notes on the colours of a fresh topotypical specimen, 37 mm. in total length, collected by Mr. G. R. F. Green, on 22nd January, 1934, are given below.

General ground colour pale translucent green; ventral surface white with a tinge of green, except on tail, which is concolorous with sides and back. Dorsal surface, which behind the head exhibits a distinct purplish suffusion underlying the green, abundantly punctulated throughout, and spotted and marbled with dark greenish. Sides marked in posterior half with spots, lighter than the ground colour, that tend to form two or three longitudinal rows, those of the lowest row the largest. Three or four obscure dark green vertical bands on the body, about as wide as their interspaces, extending about halfway down the sides. Head in general concolorous with body. Purple lozenge on nape. Purplish tinge on dorsal surface of snout, with definite narial spots of purple. Extending downwards and forwards from antero-inferior border of eye a clear unpunctulated region of pale green, subtriangular, widest inferiorly, bounded behind by a well-defined subvertical dark green band. Iris green; dark blue pupil with narrow annulus of dark orange. Ventral surface in advance of sucker in general immaculate, though the punctulations of the sides extend slightly beyond inferior profile of body, and there are also present two forwardly converging bands of punctulations visible only with a lens; behind sucker with the smaller, but without the larger, spots of sides and back. Adhesive apparatus immaculate, whitish, becoming pinkish centrally. Vertical fins more or less greenish, the dorsal with a purplish spot in its upper anterior

half, the anal with some purplish, especially near its middle, the caudal with a vertical band of purplish distally. Pectorals greenish, thickly punctulated with darker. Pelvics white, with a hint of green distally; a few small dark spots, mostly placed proximally.

A second specimen, 25 mm. in total length, collected at the same time, is generally similar in coloration, but exhibits the following variations: caudal with three vertical bars of purplish, the anterior one extending on to the caudal peduncle; dorsal and anal fins, when depressed, are seen to be crossed by distinct brownish purple bands, three on dorsal, two on anal; purplish tinge on dorsal surface of body more decided, and extending further caudad; purple lozenge on nape less conspicuous; clear triangular suborbital region less clearly defined, being to some extent encroached on by punctulations.

Family PATAECIDAE

Genus **Pataecus** Richardson, 1844

Subgenus **Pataecus**, nov.

Diagnosis. Antero-dorsal profile of snout inclined forward. No verrucae. Dorsal spines and anal rays not noticeably buried.

Orthotype. Pataecus fronto Richardson = *Pataecus (Pataecus) fronto* Richardson.

Pataecus fronto Richardson, *Ann. Mag. Nat. Hist.* XIV. 91. 1844. p. 280.
Pataecus subocellatus Günther, *Proc. Zool. Soc. London.* 1871 (1872). p. 665. pl. lxiv.

Scope and Distribution. The subgenus includes only the orthotype; Western Australia, South Australia, New South Wales, Queensland.

Remarks. In the course of supplying some data on Pataecid material in the Australian Museum, Sydney, Mr. G. P. Whitley, Ichthyologist, has called my attention to the isolated position occupied by *P. fronto*, and has suggested the present discussion of the Tasmanian members of the genus might provide a convenient occasion for recognizing this by generic or subgeneric distinction: the proposal here made for the establishment of two subgenera of *Pataecus* is the outcome of Mr. Whitley's courteous suggestion.

Subgenus **Aetapcus** nov.

Diagnosis. Antero-dorsal profile of snout inclined backward. Regularly arranged verrucae on head and body. Dorsal spines and anal rays more or less buried and hidden in fleshy membrane.

Orthotype. Pataecus maculatus Günther = *Pataecus (Aetapcus) maculatus* Günther.

Pataecus maculatus Günther, *Cat. Fish. Brit. Mus.* III. 1861. p. 292.

Scope and Distribution. The subgenus comprises *P. (A.) maculatus* Günther, Western Australia, South Australia, Tasmania; *P. (A.) vincenti* Steindachner, South Australia; *P. (A.) armatus* Johnston, Tasmania.

Aetapcus, an anagram of *Pataecus*.

Pataecus (Aetapcus) armatus Johnston

(Text-fig. 3)

Pataecus armatus Johnston, *Pap. Roy. Soc. Tasm.* 1890 (1891). p. 33. *Lapsus calami.*

Pataecus maculatus Waite, *Rec. Aust. Mus.* VI. 2. 1905. p. 76 (but not Waite's actual specimen from Tasmania, nor his figure—pl. XV.—of a specimen from Fremantle, both of which = *P. maculatus* Günther). *Id.* Waite, *Rec. S. Aust. Mus.* II. 1. 1921. p. 169 (Tasmanian reference only; not fig. 276). *Id.* Lord, *Pap. Roy. Soc. Tasm.* 1922 (1923). p. 71. *Id.* Lord and Scott, *Synopsis Vert. Anim. Tas.* 1924. p. 86. Not *P. maculatus* Günther, *Cat. Fish. Brit. Mus.* 111. 1861. p. 292.

Pataecus maculatus var. *armatus* Whitley, *Pap. Roy. Soc. Tasm.* 1928 (1929), p. 64. *Ex* Johnston MS.

Pataecus armatus McCulloch, *Aust. Mus. Mem.* v. 111. 1929. p. 398.

D. 34. A. 10. P. 8. C. 12. (The upper two rays are imperfectly developed, failing to reach the free margin of the membrane; their presence is perhaps an individual peculiarity). Gill-rakers on lower limb of anterior arch 12, low, mammilloid, denticulate.

Depth of body (41 mm.) equal to length of head (41), or 3·0 in total length (121), 2·5 in standard length (103). Eye, including rim, (4) 10·3, snout (10) 4·1, maximum depth of head (38) 1·1, depth of head at level of eye (31) 1·3, interorbital width (5) 8·2, in length of head. Length to vent (*c.* 65) *c.* 1·9 in total length.

General form similar to that of *P. (A.) maculatus* Günther. Eye with a raised rim, lying in a concavity; about equidistant from anterior and superior profiles and about two and a half times as far from ventral profile. Posterior nostril in a concavity; tubular, as wide as high; about an eye-diameter in advance of, and about half an eye-diameter below, eye. Anterior nostril apparently a simple aperture, an eye-diameter below, and slightly in advance of, posterior nostril. Cleft of mouth oblique; its horizontal length subequal to its distance from base of first dorsal spine; jaws equal anteriorly. Maxillary extending slightly behind level of eye; the width of its expanded hinder end half its distance from eye. Teeth in lower jaw villiform, forming in each ramus a well-defined band, anteriorly with five or six somewhat irregular rows, narrowing posteriorly to a single row; bands nearly meeting at symphysis, their nearest approach being in their outer half. Teeth in upper jaw similar in form and disposition, but bands less closely approximated mesially. A small semilunar patch of villiform teeth on vomer.

General surface of skin smooth. Low verrucae and lateral ridge present, disposed more or less as in *P. (A.) maculatus*. A series of tubercles, one at the base of each ray, along the whole dorsal profile.

Dorsal fin with 22 rays spinous; originating at level of upper border of eye, well in advance of eye, the 3rd spine being above the anterior ocular margin; connected posteriorly by membrane to outer third of first complete caudal ray; 1st, 2nd (stoutest), 3rd, 11th, 22nd spines 3·5, 1·9, 1·8, 3·0, 2·6, respectively, in head; 1st, 9th (longest), 12th soft rays 2·6, 2·0, 2·2, respectively, in head; the

anterior spines partly concealed in membrane, other spines and rays readily observable. Anal fin originating below 21st dorsal spine; terminating rather less than an eye-diameter in advance of level of base of median caudal rays; its base 1·5 in head, subequal to direct distance between pectoral origin and eye; its vertical height half the length of its longest (median) ray, which is 4·1 in head; all rays more or less concealed in thick membrane. Pectoral fin deeply excavate interradially; rays fairly patent, simple, the longest (3rd) 1·3 in head. Caudal fin rounded, obliquely truncated inferiorly; 2·3 in head; rays simple, the upper rather more slender than the lower.

Ground colour (in formalin) whitish, abundantly punctulated with rufous brown, the net effect being a pale greyish brown, with a distinct reddish tinge, varying in intensity in accordance with the number of punctulations, being most marked on the head, much less marked in the region covered by the pectoral in its normal, upwardly oblique position, and scarcely observable on the throat. Except the region immediately behind the opercle, which is irregularly mottled with brownish, the sides bear a number of reddish brown spots of variable size, showing some tendency to form four or five longitudinal series, each of about a dozen; two rather large isolated spots near the dorsal profile, one shortly behind the level of the operculum, the other at about the level of the anal origin. Ventral surface of body, except throat, with numerous subcircular rufous spots. Head with a number of more or less irregularly disposed subcircular rufous spots, most numerous below the level of the eye. About ten spoke-like markings radiating from eye, those at positions of ten and four o'clock (from left aspect) more conspicuous than the rest.

Dorsal fin greyish, spotted with reddish brown; largest spots tending to form half a dozen short arcs above the head, behind which they form a single row in basal half of fin, this row being surmounted by a subparallel row of smaller, more numerous spots; a few greyish spots on non-spinous portion of fin; a number of small spots and punctulations irregularly scattered over most of fin. Anal fin pale greyish brown, lightly spotted and marbled with darker. Pectoral fin pale olivaceous, slenderly barred and mottled with whitish; tips of rays light grey. Caudal fin grey, faintly yellowish; a few dark blotches in proximal half; a broad oblique inframarginal band of black, scarcely continued to upper and lower margins of the fin.

Material examined. Described and figured (Text-fig. 3) from a specimen, 121 mm. in total length, 103 mm. in standard length, in the Queen Victoria Museum, Launceston (Reg. No. 891).

Locality. Northern Tasmania.

Affinities. The specimen here described differs from *P. (A.) maculatus* Günther chiefly in colour-pattern, in the smooth skin, and in having more dorsal and fewer anal rays. It is identified with

P. armatus mainly on the strength of the characteristic coloration, since Johnston notes his specimen as having D. 32; A. 12. There is, however, some confusion in Johnston's account, since, after giving these radial characters and correctly citing ' D. 31; A. 12 ' for the type-specimen of *P. (A.) maculatus* from Fremantle, he expresses the opinion that his specimen represents ' only a local variety which probably varies slightly in colour and in the number of dorsal *and anal* rays ' (italics mine).

Remarks. Johnston's specimen has been lost, and no further examples appear to have been met with since. The species is here for the first time fully described and figured. The involved history

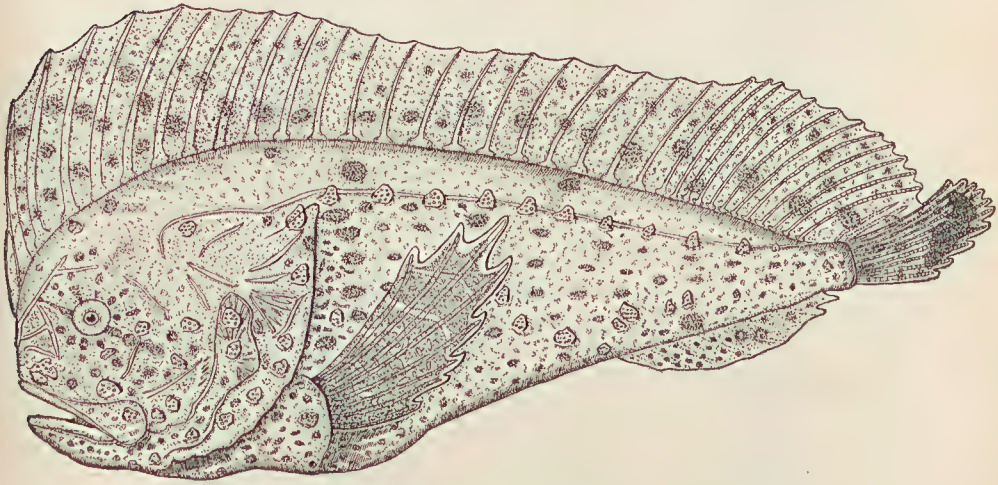

Fig 3.—*Pataecus (Aetapcus) armatus* Johnston. A specimen from Northern Tasmania. Natural size.

of this species implicit in the synonymy set forth above is deserving of a few lines of elucidation. Waite first (1905, p. 76) correctly suspected that the ' *Pataecus armatus* Günther ' of Johnston's second list (1891, p. 33) was a straightout *lapsus calami* for *P. maculatus* Günther; and later (1921, p. 169) formally relegated the former to the synonymy of the latter. Lord (1923, p. 71), and Lord and Scott (1924, p. 86), included *P. maculatus* on their lists, relying, it seems, solely on Johnston's record, as interpreted by Waite (1921)[1]. Whitley (1929, p. 64), making available Johnston's original memo-

[1] The grounds of this opinion are: (*a*) absence of actual Tasmanian records in Lord and Scott; (*b*) inquiry shows no specimens were then available either in the Tasmanian Museum, Hobart, or the Queen Victoria Museum, Launceston; (*c*) internal evidence of the references cited by Lord and Scott. The real case for the recognition of *P. (A) maculatus* as a member of the Tasmanian fauna is discussed in the remarks on that species below.

randa, accepted a manuscript suggestion, and regarded Johnston's fish as a variety, *P. maculatus* Günther, var. *armatus* Johnston; while McCulloch (1929, p. 398) elevated it to full specific rank.

Pataecus (Aetapcus) maculatus Günther

Pataecus maculatus Günther, *Cat. Fish. Brit. Mus.* 111. 1861. p. 292. See also synonymy listed under *P. (A.) armatus* above.

Record. There is a specimen from Northern Tasmania (probably Tamar Heads) in the Museum collection (Reg. No. 890).

Pataecus (Aetapcus) maculatus Günther has at present no satisfactory standing in the Tasmanian list. It is not accredited to Tasmania by McCulloch in the Check-List; while reasons have already been given, in the course of the remarks on *P. (A.) armatus*, for considering it highly probable that the references to it in the lists of Lord, and Lord and Scott, really relate to *P. (A.) armatus.*

A Tasmanian specimen of a *Pataecus* was, however, referred by Waite (1905, p. 75), probably correctly, to this species. Waite's record was, I believe, overlooked by Lord and Scott; while McCulloch either overlooked it, or else, more probably, assumed the specimen to be referable to *P. (A.) armatus.*

Waite observes of his specimen that it differs from a topotypical example of *P. (A.) maculatus* 'by having thirty-three dorsal spines [*i.e.*, total rays] and especially in the length of the pectoral fin, which is longer than in the Western Australian fish, and almost as long as the head. The body also is relatively deeper; these slight variations may be of individual or local import only'. The present example shares the first two, but not the third, of these peculiarities; and in view of the interesting character of these variations, the principal proportions of the specimen here noted are recorded below, as a basis for future investigations. The radial formulae are: D. 33 (xx, 13); A. 12; P. 8; C. 9.

Proportions. Depth (66 mm.) 3·2, depth at origin of anal (33) 6·4 head (60) 3·5 in total length (211); or 2·8, 5·6, 3·1, respectively, in standard length (184). Eye (4) 4·3, interocular width (10) 1·7, in snout (17). Length to vent (131) 1·6 in total length. Longest (3rd) dorsal spine (30) 2·0, longest (9th) dorsal ray (31) 1·9, longest (10th) anal ray (24) 2·5, longest (3rd) pectoral ray (57) 1·1, longest (3rd) caudal ray (27) 2·2, in head.

Summary

1. Some general observations are made on *Lovettia sealii* (Johnston) [whitebait-constituent], *Genypterus blacodes* (Bloch and Schneider) [colour-variation], family Gobiesocidae [key to Australian species], and *Volgiolus cardinalis* (Ramsay) [life-colours].

2. Little-known species described and figured are *Aspasmogaster tasmaniensis* (Günther), and *Pataecus armatus* Johnston.

3. The inclusion in the Tasmanian list of *Pataecus maculatus* Günther is confirmed.

4. *Pataecus* and *Aetapcus*, new subgenera of *Pataecus* Richardson, are diagnosed.

5. *Ophiclinus greeni*, sp. nov. (family Ophiclinidae) is described and figured.

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A new Mygalomorph Spider belonging to the Genus *Hexathele* Ausserer

By

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(Read 11th November, 1935.)

The genus *Hexathele* Ausserer (1871) contains only five known species. The genotype, *Hexathele hochstetteri* Auss., was collected in New Zealand by the Novara Expedition. Since then three other species have been recorded from that country, namely, *H. petreii* Goyen (1886), *H. huttoni* Hogg (1908), and *H. websteri* Hogg (1908). A fifth species, *H. montanus* Hickman, was recorded from Tasmania by me in 1926.

In referring to *H. hochstetteri* and *H. petreii*, Hogg (1901) remarks, 'Except a discrepancy in the eyes I can find no difference in the descriptions of these two species'. Goyen's description of the male of *H. petreii* is so brief and vague that it gives little help in establishing the identity of the species. His description of the female, however, is definite in regard to the dentition of the chelicerae and the structure of the tarsal claws. He states (1886) that the groove of the falces has a large number of teeth on each side, and that the inferior tarsal claw is 'much bent but without teeth'. In regard to *H. hochstetteri*, Ausserer (1871) remarks 'die Afterklaue ist mehrzahnig', and in his diagram shows the inferior tarsal claw of the first pair of legs as having three teeth. Hogg apparently overlooked these features until 1908, when he received further specimens of the genus from New Zealand, and was able to recognize as a new species *(H. huttoni)* a form which he had previously (1901) regarded as identical with the genotype.

Rainbow (1920, p. 85) has tentatively recorded *Hexathele hochstetteri* as occurring in Papua, but thinks it quite possible that 'the specimens may have accidentally found their way into the bottle of Papuan material'.

E. Simon (1888, p. 222) described a spider from Chili under the name of *Hexathele cinereo-pilosa*, but subsequently made it the genotype of a new genus, *Scotinoecus* (1892).

The present paper gives a synopsis of the species of *Hexathele*, followed by a description of a new species, *H. fentoni*, from Tasmania.

Family DIPLURIDAE

Genus **Hexathele** Ausserer, 1871

Key to the Females of the Species of Hexathele

1. Inferior tarsal claw with teeth 2
   Inferior tarsal claw without teeth 3
2. Tarsi of first and second pairs of legs armed with spines. Cephalothorax black .... *H. montanus* Hickman
   Tarsi of first and second pairs of legs devoid of spines. Cephalothorax red-brown .... *H. hochstetteri* Ausserer
3. Both margins of cheliceral furrow with teeth .... *H. petreii* Goyen
   Retromargin without teeth 4
4. Front median eyes once their diameter apart .... *H. websteri* Hogg
   Front median eyes less than their diameter apart 5
5. Abdomen dark-grey without pattern .... *H. huttoni* Hogg
   Abdomen yellow-brown with pronounced pattern .... *H. fentoni*, sp. nov.

Hexathele fentoni, sp. nov.

Male. Holotype.

	mm.
Total length (excluding chelicerae and spinnerets)	11·0
Length of cephalothorax	5·2
Breadth of cephalothorax	4·3
Length of abdomen	5·5
Breadth of adbomen	3·5

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
	mm.	mm.	mm.	mm.	mm.	mm.
Leg 1	4·3	2·2	3·0	3·4	2·4	15·3
2	3·9	2·0	2·9	3·6	2·4	14·8
3	3·5	1·7	2·3	3·6	2·4	13·5
4	4·7	2·0	3·2	4·2	2·4	16·5
Palpi	2·9	1·4	2·0	—	1·0	7·3

Width of first patella at 'knee' 0·840 mm. Tibial index 16·1.
Width of fourth patella at 'knee' 0·812 mm. Tibial index 15·6.

Carapace. Ovate, truncate in front. Rear margin slightly indented. Surface glabrous except for a median longitudinal row of black hairs extending from ocular tubercle to fovea. Lateral margins fringed with coarse black hairs. Radial grooves distinct. Thoracic fovea 3·2 mm. from front margin, very slightly recurved. Cephalic region moderately high. Clypeus equal to slightly more than half the diameter of AME. The articular membrane between the base of the chelicerae and the carapace is faintly marked with black patches.

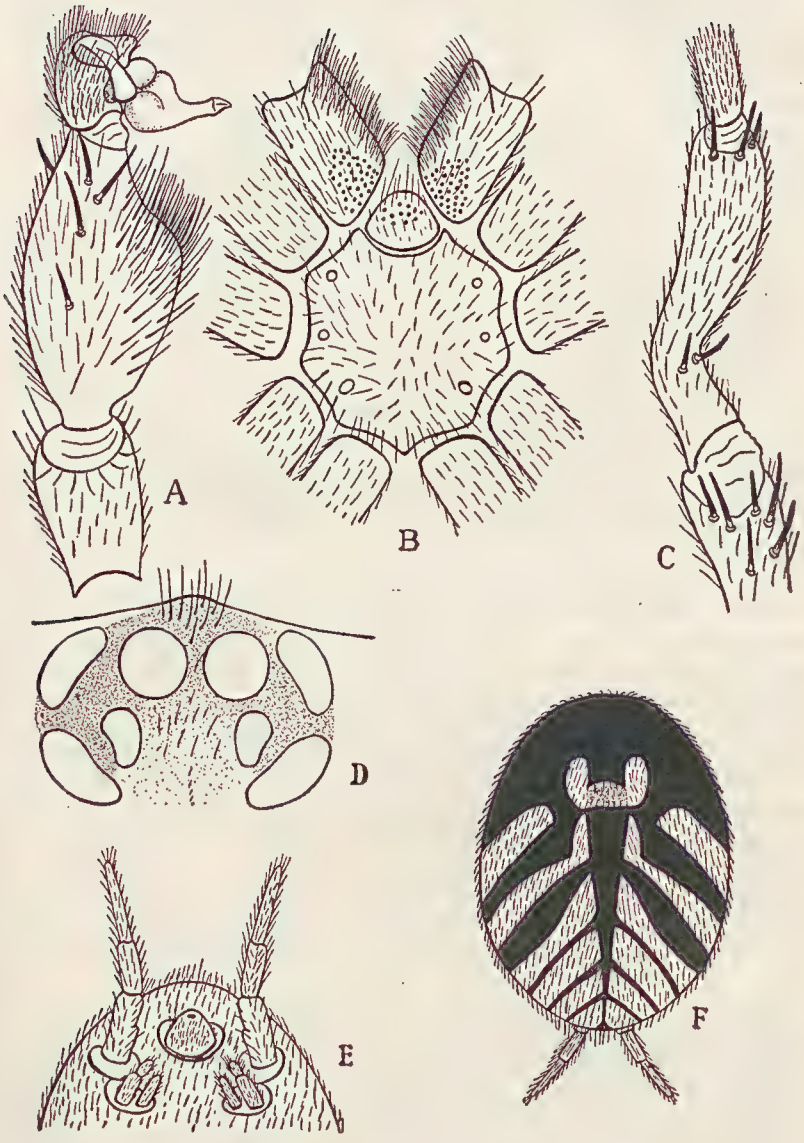

Fig. 1.—*Hexathele fentoni*, sp. n.

A.—Ventral view of left palpus of male. B.—Sternum, labium, and maxillae of male. C.—Ventral view of left metatarsus of first pair of legs of male. D.—Eye-group of male. E.—Spinnerets of male. F.—Dorsal view of abdomen of female, showing pattern.

Eyes. The eye-group is wider than long in ratio 19 : 11. Ocular tubercle pigmented with black between the eyes. In front of the eye-group are nine or ten stiff curved bristles. Anterior row of eyes straight by anterior edges; posterior row recurved. Ratio of eyes AME : ALE : PME : PLE = 5 : 6 : 3·5 : 6. AME are separated from each other by 2/5 of their diameter and from ALE by 1/5 of the diameter of the AME. The PME are separated from each other by 7/5 of the diameter of the AME. The laterals are separated by 2/5 of the diameter of the AME. (Text-fig. 1. D.)

Chelicerae. Basal segment 2·3 mm. long, dark-brown. Dorsal and retrolateral surfaces glabrous. Front and dorso-prolateral margin clothed with bristles. Rastellum absent. Fang 2·9 mm. long, slender, sharp, and curved. Promargin of furrow with nine large and three or four minute black teeth. Retromargin with a scopula, but without teeth.

Labium. Broader than long. Rounded in front. Clothed with long hairs and armed with 13 small cuspules. The groove separating the labium from the sternum is very shallow and dark-brown.

Maxillae. 1·7 mm. long by 1·0 wide. Provided with a scopula of fine red hairs and about 38 small cuspules on the basal third. (Text-fig. 1. B.)

Sternum. Light-brown, shield-shaped, longer than wide in ratio 40 : 38. Thinly clothed with coarse black bristles, and marked with three pairs of sigilla. The first and second pairs of sigilla are small and circular, the third pair larger and oval, separated from the margin by their length. (Text-fig. 1. B.)

Legs. 4. 1. 2. 3. Light-brown. Clothed with black hairs and bristles, but without a definite scopula. Trichobothria on all tarsi, metatarsi, and tibiae. Metatarsi of first pair of legs dark-brown and sinuous (Text-fig. 1. C). Tibiae normal. Upper tarsal claws with a row of 7 or 8 teeth crossing the claw obliquely. The inferior claw is small and devoid of teeth.

Palpi. Light-brown, clothed with black hairs and bristles. Genital bulb pyriform, ending in a short, twisted, lance-shaped style. Tibia dilated and furnished with numerous coarse bristles on the swollen part. (Text-fig. 1. A.)

Spines.—First leg. Femur: dorsal 1-1-1-1-1-1-1-1, prolateral 1-1, retrolateral 0, ventral 0. Patella: dorsal 0, prolateral 1-1, retrolateral 0, ventral 2-2. Tibia: dorsal 0, prolateral 1-1, retrolateral 0, ventral 2-1-2-1-3. Metatarsus: ventral 2-1-3, elsewhere 0. Tarsus: ventral 1-1, elsewhere 0. *Second leg.* Femur: dorsal 1-1-1-1-1-1-1-1, prolateral 1-1-1-1, retrolateral 1-1-1-1, ventral 0. Patella: dorsal 0, prolateral 1-1, retrolateral 0, ventral 2r. Tibia: dorsal 0, prolateral 1-1, retrolateral 0, ventral 1-2-1-2-3. Metatarsus: dorsal 1, ventral 2-1-2-1-4, elsewhere 0. Tarsus: dorsal 0, prolateral 1, retrolateral 1-1, ventral 0. *Third leg.* Femur: dorsal 2-2-2-2-2, prolateral 1-1, elsewhere 0. Patella: dorsal 0, prolateral 1-2, retrolateral 1-1, ventral

1r. Tibia: dorsal 1-1-1, prolateral 1-1-1-1-1, retrolateral 1-1-1, ventral 3-2-1-3. Metatarsus: dorsal 1, prolateral 1-1-1-1-1, retrolateral 1-1-1, ventral 2-2-1-3. Tarsus: dorsal 0, prolateral 1-1-1-1, retrolateral 1-1-1-1, ventral 1-1. *Fourth leg.* Femur: dorsal 2-1-1-1-1-1-1, elsewhere 0. Patella: ventral 1r, elsewhere 0. Tibia: dorsal 1 basal, prolateral 1-1, retrolateral 1-1-1, ventral 3-1-3-3. Metatarsus: dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-1-1-2-1-1-4. Tarsus: dorsal 0, prolateral 1-1-1-1-1-1, retrolateral 1-1-1-1-1-1, ventral 1-1. *Palpus.* Femur: dorsal 1-1-1, elsewhere 0. Patella: prolateral 1, elsewhere 0. Tibia: retrolateral 1-1-2, elsewhere 0. Tarsus 0.

Abdomen. Brown. Clothed with black bristles anteriorly and dorsally. Sides and ventral surface clothed with fine black hairs. Dorsal surface marked with five pairs of dark oblique stripes and a median stripe as in the female. (Text-fig. 1. F.)

Spinnerets. Six. Yellowish-brown, clothed with black hairs. Posterior pair 3·5 mm. long, four-jointed above and three-jointed below, separated at the base by 1·5 mm. The other four spinnerets are in a straight line immediately in front of the posterior pair. The outer pair are two-jointed and 1·0 mm. long. The inner pair are one-jointed and 0·6 mm. long. The inner pair are separated from each other by 0·7 mm. Anal tubercle, yellowish, very large, and projecting between the posterior spinnerets. (Text-fig. 1. E.)

Female. Allotype.

	mm.
Total length (excluding chelicerae and spinnerets)	15·0
Length of cephalothorax	7·0
Breadth of cephalothorax	4·8
Length of abdomen	8·0
Breadth of abdomen	5·8

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
	mm.	mm.	mm.	mm.	mm.	mm.
Leg 1	4·6	2·3	2·8	2·8	2·0	14·5
2	3·9	2·2	2·4	2·6	1·8	12·9
3	3·4	1·8	1·8	2·5	1·7	11·2
4	4·6	2·3	2·8	3·1	1·7	14·5
Palpi	2·8	1·4	1·9	—	1·8	7·9

Width of first patella at 'knee' 0·986 mm. Tibial index 19.
Width of fourth patella at 'knee' 0·870 mm. Tibial index 17.

Carapace. Ovate, chestnut-brown. Front margin truncate, rear margin indented. Sides fringed with a few short hairs. Radial grooves distinct and slightly darker in colour than the rest of the carapace. Thoracic fovea deep and almost straight. Surface of carapace smooth and glabrous, except for a median row of black hairs extending from eye-group to fovea. Clypeus narrow. Articular membrane between the carapace and chelicerae suffused with black.

Eyes. Eye-tubercle moderately high. Eye-group wider than long in ratio 23 : 12. Space between the eyes black. A group of about twelve bristles in front of the eyes and a smaller group between the

posterior median eyes. Anterior row of eyes straight by anterior edges, posterior row recurved. Ratio of eyes AME : ALE : PME : PLE = 6 : 7 : 4 : 6. AME separated from each other by half their diameter and from ALE by 1/6 their diameter. PME separated from each other by 11/4 of their long axis and from PLE by 1/4 of their long axis. Laterals separated by 2/7 of the long diameter of ALE.

Chelicerae. Basal joint 3·5 mm. long and almost black. The dorsal surface smooth and glabrous. Anterior surface clothed with black bristles. Rastellum absent. Promargin of furrow with a row of 12 teeth, of which the distal three are the smallest. Retromargin with a reddish scopula, but without teeth. A row of four minute teeth in the basal third of furrow. Fang long and well curved.

Labium. Convex, wider than long in ratio 23 : 15. Clothed with long fine bristles and armed with a group of 21 cuspules. Sternal suture procurved.

Maxillae. With parallel sides. Distal inner angle slightly produced. Scopula red. Surface clothed with bristles. A group of 29 cuspules on basal third.

Sternum. Width equal to length. Convex. Clothed with erect black bristles. Margin produced into blunt points between the coxae. Sigilla as in the male.

Legs. (1. 4.) 2. 3. Clothed with black bristles. True scopulae absent. Trichobothria on tibiae, metatarsi, and tarsi. Three tarsal claws. Superior claws with seven teeth. The inferior claw devoid of teeth. Palpal claw with six teeth.

Spines. First leg. Femur 0. Patella 0. Tibia: dorsal 0, prolateral 1, retrolateral 0, ventral 1-1-1-2. Metatarsus dorsal 0, prolateral 0, retrolateral 0, ventral 2-1-3. Tarsus: dorsal 0, prolateral 0, retrolateral 0, ventral 1r. *Second leg.* Femur 0. Patella: prolateral 1, elsewhere 0. Tibia: dorsal 0, prolateral 1, retrolateral 0, ventral 2-1-1-2. Metatarsus: dorsal 0, prolateral 1, retrolateral 0, ventral 2-2-4. Tarsus: ventral 1r, elsewhere 0. *Third leg.* Femur 0. Patella: prolateral 1-1, elsewhere 0. Tibia: dorsal 1-1, prolateral 2-3-2, retrolateral 1-1-1, ventral 2-2-2. Metatarsus: dorsal 2-2, prolateral 1-1-1-1, retrolateral 1 at apex, ventral 1-3-3-1-3. Tarsus: ventral 2-2, elsewhere 0. *Fourth leg.* Femur 0. Patella 0. Tibia: dorsal 0, prolateral 2-2-1, retrolateral 1d, ventral 2-2-2. Metatarsus: dorsal 2-2, prolateral 1, retrolateral 0, ventral 1-1-2-1-3. Tarsus: ventral 1-2-2-2-2, elsewhere 0. *Palpi.* Femur 0. Patella 0. Tibia: dorsal 0, prolateral 1-1-1, retrolateral 2-2-2, ventral 1. Tarsus: dorsal 0, prolateral 1-1-1-1-1, retrolateral 1-1-1-1, ventral 1.

Abdomen. Yellowish-brown. Clothed with black hairs. Dorsal surface marked with a median black stripe, which becomes narrower posteriorly. Six pairs of greyish-black oblique stripes on the sides. (Text-fig. 1. F.) Ventral surface yellowish-brown with a faint greyish median patch.

Spinnerets. Six. Posterior pair 4·3 mm. long, four-jointed on dorsal surface, three-jointed on ventral surface. The two anterior pairs are short and almost in the same transverse line, immediately in front of the posterior pair. The outer pair two-jointed, the inner pair one-jointed. The inner pair are separated from each other by 5/2 times their diameter.

Locality. National Park, Tasmania. (3450 feet.) 27th March, 1932.

Field Notes. Both male and female specimens were collected near the southern end of Lake Fenton. The spider makes a simple burrow, lined with silk, but not provided with a lid. The nests are fairly numerous in mossy banks among the deciduous Beeches *(Notofagus gunnii)* and Grass-trees *(Richea pandanifolia)* near the accommodation huts.

Type Specimens. The holotype male and allotype female have been placed in the Australian Museum, Sydney.

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Experiences of a Settler in the Early Days of Van Diemen's Land[1]

By

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(Read 8th April, 1935)

The Reverend John West, author of *The History of Tasmania*, writing in 1852, made these observations (p. 66):

> 'The landing of settlers, direct from Great Britain, was an important event: their efforts were experiments, and their achievements were prophetic. The political philosopher may trace, in their errors, trials, and successes, the lessons afforded by experience for the instruction of nations. The rapid advance of civilization tends to underrate the first efforts of our predecessors. The first colonial boatbuilder founded a great commercial navy: the first shepherd held in his slender flock a treasure of unimaginable worth.'

While making due allowance for the rhetorical flourishes of Mr. West's sonorous style, I have always felt that there is much truth in this paragraph, especially as to the tendency to underrate the efforts of our pioneers, or, at any rate, to forget the courage which prompted them to risk, and enabled them to overcome, the hardships and trials which inevitably awaited them in this far-off land in the early days of last century.

In the early years of the nineteenth century Van Diemen's Land was a practically unknown quantity, the voyage out lasted nearly six months, and the only ships available were small, ill-found vessels of a few hundred tons burthen. Moreover, few of these voluntary exiles from the home-land could look forward, with any assurance, to revisiting their native land. Long and anxious must have been the family conclaves ere the fateful decision could be made.

One of the main inducements to emigration at that time was, of course, the depression that hung like a pall over Europe after the Napoleonic wars. The situation was, in many respects, extraordinarily like that of the present day. Prices were low, the burden of taxation was heavy, and trade was stagnant.

[1] The following notes regarding the experiences of the pioneer settlers of V.D.L. are taken mainly from the correspondence of Mr. John Leake and his wife who arrived in Hobart Town in 1823 and from the diary of my grandfather, Dr. John Maule Hudspeth, who arrived in 1822.

From 1820 onwards a succession of publications drew attention at Home to the attractions of Van Diemen's Land. It was described (says West, p. 67) in *The Quarterly Review* for May, 1820, by a friendly pen, which stated that during three years a detachment of 100 men had not lost three, and that Hobart Town had been sixteen months without a funeral!

Lieut. Jeffreys, who came out to Van Diemen's Land in command of the brig *Kangaroo*, James Dixon, commander of the *Skelton*, and Edward Curr, the first Manager of the V.D.L. Coy., all published, between 1820 and 1824, books describing the island and advising intending settlers. G. W. Evans, the first Surveyor-General of Van Diemen's Land, who also came out in the *Kangaroo*, published in 1822 a description of Van Diemen's Land, in which he accuses Jeffreys of having appropriated on board ship some of his manuscript, and included it in his book. Evans' book contains a sketch of Hobart Town as it was in 1822. Curr's book contains a lengthy narrative of the career of Michael Howe, the notorious bushranger. Dixon includes in his book a copy of Macquarie's report of his visit to Van Diemen's Land in 1821, in which the population of the island is stated to be 6372 persons.

Godwin's *Emigrants' Guide to Van Diemen's Land*,[1] published in 1823, contains advice as to the procedure to be adopted to obtain a grant of land, and other useful information; also a small map of the island, and an interesting sketch of Hobart Town.

Among the letters to which I have had access is one written to the late Mrs. John Leake by her father, on the eve of her departure, with her husband and family, to Van Diemen's Land in 1822. In it he says:

> 'When I look back to your early childhood and consider that there was then not even the most distant prospect of your ever living or travelling beyond your native island . . . . to now hear you talk of removing almost as distant as it is possible to be . . . . not rashly, but calmly considering the privations and inconveniences naturally, with so many small children, attendant on so arduous an undertaking, is a proof of a great mind, fortified by a sense of duty rarely to be met with. May you both be blessed . . . . What may be the difficulties to be encountered in Van Diemen's Land I know not, and dislike to conjecture: of this I am assured—be they what they may, you would bear them with fortitude. But I hope and pray that fortitude may not require to be exerted . . . I truly hope, present difficulties over, you will find a resting place, and that the end will be peace.'

[1] Curr (p. viii) severely criticizes Godwin's Guide as containing 'false and delusive assertions,' betraying 'gross ignorance.'

The decision taken, preparations for the voyage were immediately begun. The house and furniture at Hull were disposed of. Passages were secured on the brig *Andromeda*—a first-class cabin for Mr. and Mrs. Leake and the two youngest children, and berths in the steerage for the four elder children and three servants. The total passage-money was £380.[1]

Then came the purchase of the long list of articles to be taken for their new enterprise. These and the luggage were included in an insurance policy for £1500. They included the following items:—Wine, hardware and saddlery, paint, oil, slops, clocks, glass, soap, mustard, tins and corks, earthenware, corn mill, agricultural implements, plate, silks and ribbons, six chests of luggage, and one box of dollars. This formidable list gives us some idea of the forethought demanded of the intending settler in those days, and of the limited resources of the island.

In addition to all these, there was a most important item, viz., four Saxon sheep, with which Mr. Leake hoped to start his pastoral activities. These were procured in Leipzig, and, after a passage down the Elbe, shipped across to the Port of Leith, to be placed on board the *Andromeda*. For this a special licence had to be obtained, of which the following is a copy:—

Treasury Chambers,
10th September, 1822.

To John Leake,
Leith.

Sir,

I am commanded by The Lords Commissioners of the Treasury to acquaint you that my Lords have directed the Commissioners of Customs in Scotland to permit you to import from Hamburg to Leith Four Saxon sheep to be re-exported duty free to Van Diemen's Land, as required by you.

I am, Sir,
Your obedient servant,
R. LATHERGLEN.

Among their fellow passengers on the *Andromeda* were Messrs. Lewis Gilles and R. Horne, both of whom afterwards settled in the Macquarie District, and Dr. A. J. Ross, the well-known publisher of the early almanacs, who also cultivated other branches of authorship, verse, pamphlets, and an ethnological treatise; also the Rev. J. D. Lang, one of the first Presbyterian ministers in New South Wales, who afterwards started a newspaper in that colony; and letters of introduction were secured from Earl Bathurst and William Wilberforce to Sir Thomas Brisbane, Governor of New South Wales, and

[1] Average passage-money, £70 to £100 for cabin passengers, and £35 to £40 for steerage. Average duration of voyage, 100 to 140 days. (Curr.)

to Mr. Bromley, Naval Officer at Hobart Town. Mr. Wilberforce's letter is, perhaps, worthy of quotation:—

Sir, December 2nd, 1822.

The Post which arrives late and goes out early at this place, allows one but a minute or two for writing to you, in addition to Letters in your behalf which I have just now dictated, to Sir Thomas Brisbane, and to Mr. Bromley, Naval Officer at Hobart Town.

I have also written in your favour to Earl Bathurst . . . And I can now only add my cordial good wishes, which the account of you received thro' Miss Terry has produced. (I well know the value of her praises), that it may please God to render your settlement in the Australasian Hemisphere productive of benefit to you and yours and to the community to which you belong.

Above all, may we be travelling the same road, though by different routes, and meet at length in a World of Holiness and Happiness and Love and Joy.

I remain with esteem

Sir

Your faithful

W. WILBERFORCE.

You had better not mention that my Letter to you is in my own Hand. In fact I should have dictated it, but my amanuensis is out of the way. I will just add, if this reaches you before you sail from England it may a little contribute to cheer you, that I have often thought were I to begin life in circumstances which did not promise much at Home, I would carry my family to Van Diemen's Land.

Mr. John Leake,
On board of the *Andromeda*,
Bound to Van Diemen's Land, at, or off, Falmouth.

Before embarkation the passengers were supplied with a complete schedule of the dietary to be enjoyed during the voyage. The schedule concludes with this significant paragraph:

> 'But the substituting of one article for another is to be at the entire control and pleasure of the Captain as he may find it convenient or desirable during the voyage.'

Notwithstanding this display of care for the welfare of the passengers' health, it became necessary, before the shores of England were left behind, for Mr. Leake to complain to the ship's agents of the quality of the food supplied to his children. The justice of the complaint was admitted, but the fact that it had been made unfortunately antagonized the captain, and was the cause of much misery and discomfort.

In passing it may be noted that, as was customary in those days, the ship sailed first westward, to call at Rio de Janeiro and to pick up the trade winds for the remainder of the voyage to Australia.

It appears from the *Sydney Gazette* shipping news for 1823 that the *Andromeda* left England on the 10th December, 1822, and arrived at Sydney, *via* Rio and Hobart Town, on 7th August, 1823—the voyage thus taking eight months.

Andrew Bent's *Almanac* for 1824 says that she reached Hobart Town on the 7th May, 1823—a quick passage.

In the early 'twenties of last century Hobart Town was little more than a depot for the reception of convicts. A few solid buildings for the military and civilian officials of the Home Government, and for the rest a number of rather ramshackle cottages, scattered in all directions, with the rivulet flowing along wooded banks to the blue waters of the Derwent. There were four water-mills on the Hobart Rivulet. (Evans, p. 61.)

Lieut. Charles Jeffreys, R.N. (1820), says that the town contained 300 houses and 1200 inhabitants. The houses were of one story (with the exception of Mr. Birch's, now known as Macquarie House, which was of three stories, with an embattled parapet). Government House was in the centre of the main street, adjoining a square, known as 'George's Square.' There was a church (old St. David's) 'of modest dimensions,' a gaol (in Murray-street, on the site of the Hobart Savings Bank), and the Military Barracks, in Murray-street, near what is now Hadley's Hotel.

The town must have grown rapidly, for West (1852) says that in 1821 it contained 426 houses and 2700 inhabitants, and Edward Curr (1824) says that in 1824 it contained 600 houses and a population of 3500, 'with new buildings rising up every day.'

The city had been laid out in 1811, under instructions from Governor Macquarie, by Meehan and Evans (the first Deputy Surveyor-General), but the streets were not formed. (Bigge's Report.)

Curr says the farm-houses in the country were mostly constructed of sods, logs, or mud, and thatched with straw.

In my grandfather's diary, written in 1822, he says, speaking of Hobart Town:

> 'There is very little cleared land in the vicinity of the Town. The streets are almost impassable for mud, and there is no meat of any kind to be had. Everything else is very dear. On Sunday I attended the Church (old St. David's). The Church is neat and commodious, the convicts sitting in the gallery set apart for them, and the free settlers and soldiers accommodated below. The attendance was, however, very thin. Service was performed too much in the Cathedral style, and the music more theatrical than sacred.'

Apparently the officiating clergyman's (Rev. Robert Knopwood's) reputation for spirituality was not remarkable, for he says, 'The Parson is not a man calculated to reform a depraved society, either by precept or example. He is both a swearer and a drunkard, and of course can have little real piety.'

From the first day of his arrival the newcomer was beset with difficulties. Often, upon unloading his effects, they were found

to be destroyed or damaged by seawater which had got into the ship's hold. Even after they had been landed, they were frequently stolen on the shore, so frequently, indeed, that no one took any notice, and it was impossible to obtain redress. Then it was difficult to get any useful information from the officials, without bribing them, as to the land available for selection, and even when this had been obtained, there was the problem of getting up-country to inspect. In the same diary Dr. Hudspeth narrates how he eventually got away to examine the country round Jericho, which he had been advised was a suitable place for settlement. The Derwent River was crossed at Austin's Ferry, the country passed through being described as 'thickly wooded and little cultivated.' Treeless plains were passed, on which the town of Brighton was projected, with the intention of making it the capital. At Green Ponds a gang of convicts were employed in making a road. Oatlands had not yet been laid out, and at York Plains more convicts were encountered, quarrying stone for a bridge across the river. At this time the Main-road was completed as far as Constitution Hill. (Evans, 1822, p. 84.) Jeffreys says he drove from Hobart Town to Port Dalrymple over beautiful level pasture without more than 20 miles of road. (Evans, p. 87.)

On returning to Hobart, preparations were made to proceed into the country to settle. After considerable difficulty and delay a pair of bullocks was purchased for thirty guineas, together with a cart, for which a licence had to be obtained. It was difficult to get anything together, as 'No one's word was to be depended upon,' and a general muster of convicts held two days previously was kept up 'as a drunken festival.' (This sounds more like Governor Davey's administration than that of Governor Sorell!) However, at last a start was made, with three convict servants, Mrs. Hudspeth, with a baby daughter, being on the bullock-dray. The road was almost impassable, and progress was very slow. At Spring Hill the bullocks refused to go on, and the night was spent where they were, enlivened by an attack by two footpads, who demanded Mr. Hudspeth's gun, and he was held in considerable suspense until the return with light and firearms of the two men whom he had sent ahead for assistance. When Jericho was finally reached the little family took up its abode in a hut consisting of two rooms, divided by a partition made of wattle and clay, one being occupied by the family, and the other by the assigned servants. The bed for the master and his wife was made out of materials which 'in the morning had been growing on the plain.'

The system of assigning prisoners to settlers as servants was introduced by Governor King in 1804. (West, 1852, p. 126.) These assigned servants were apparently treated with considerable severity, especially for offences against discipline, and in regard

to women, the latter due, no doubt, to the necessity for protecting them in their isolation. Thus we find that soon after their arrival at Bowsden, one of Dr. Hudspeth's servants was sentenced to 100 lashes and to be transported to Macquarie Harbour for the remainder of his original sentence, of which twelve years was unexpired. This was for insolence to Mrs. Hudspeth during the doctor's absence in Hobart Town.

In noting this in his journal Dr. Hudspeth states:

> 'Macquarie Harbour is a penal settlement which was established a few months ago, for the purpose of sending re-convicted offenders to; they are there hard-worked, ill-fed, and well whipped, and escape is impracticable. All who have attempted it have perished. A party of six, or eight, who ran off at first, were never more heard of, and some soldiers sent in pursuit of them never returned. Lately eight men made the attempt; two of whom got back, and just lived long enough to relate a horrid tale. By their account, the country on the West Coast is so rugged and barren that there is not a living creature to be seen, and it is intersected with ravines so deep and narrow that the sun's rays cannot penetrate to the bottom. In some of these chasms they were often up to the middle in dead leaves and moss, and the precipices above them were almost inaccessible. Their provisions were soon expended, and despair took possession of their savage breasts. It was proposed that one of the party should be slaughtered to feed the rest, and one of the name of Busby was doomed to be the victim, for he had planned their escapade, and undertaken to conduct them across the country to some settlement, and immediately they began with savage fury to murder him. He implored them to allow him to bleed himself to death, but in vain. They cut off his head, tore out his heart, and fried it, and afterwards gorged themselves upon his body. However, they all died but two, and they died also after their return.'

It may be useful at this point to digress for a moment, in order to explain the procedure adopted at that time by an intending settler to obtain a grant of land.

From 1803 to 1825 Van Diemen's Land was, in effect, a dependency of New South Wales, the colony not being granted responsible government until the latter year. Before leaving England the settler had to obtain from the Secretary of State for the Colonial Department an order to the Governor-in-Chief in Sydney, or the Lieut.-Governor in Hobart Town, authorizing him to issue a grant to the settler 'proportional to the means he may possess of bringing it into cultivation.' (Curr, 1824, pp. 92 *et seq.*)

Curr says the minimum amount of capital required to secure a grant was £500, but Jeffreys (1820) says that £200 would secure 200 acres. According to Evans (1822, p. 114) the Colonial Department required all settlers to have at least £500. (This regulation was probably invalid, as the Act 53 George III. c. 155 authorized any subject to settle in Australia without any licence.)

On arrival the settler lodged his letter with the Lieut.-Governor, together with a statement of his assets. He was presented by the Naval Officer to Lieut.-Governor Sorell, who pointed out the most eligible districts in which land was to be obtained. (It is said that Sorell was a most zealous immigration officer, and often succeeded in persuading those who had intended to settle in New South Wales to stay in Van Diemen's Land.)

The area granted was based upon the settler's means, as disclosed in his statement, but the maximum area was from 2000 to 2560 acres. In 1824 the Colonial Office fixed the maximum at 2560 acres and the minimum at 320 acres. Possession of £3000 would entitle him to 2000 acres, £1000 700 acres, and £500 to 400 to 500 acres.

Governor Davey was allotted a grant of 3000 acres by way of compensation for the capture by the Americans of his baggage, and this was the largest grant ever made to an individual. (West, p. 51.)

Extra land was occasionally given to settlers who had proved their worth and industry or done signal service to the colony, e.g., Gatenby, Batman, &c.

Having selected the spot on which he wished to settle, the next step was to obtain from the Deputy-Surveyor written permission to locate himself there. This was called a 'location order.' Owing to the delays which occurred in the issue of grants, many titles were founded upon these location orders alone.

There was also a regulation (not always enforced) that the settler should enter into a bond to maintain, if required, for a certain number of years, one prisoner for every 100 acres granted. If he took a second convict for one year, he was given a bonus of 100 acres.

Rations for the settler and his servants were also given at first.

Owing to the abuses which arose under this system, Governor Arthur set up a Land Board in 1828. Free grants were discontinued, and land was sold, at first by tender, and from 1831 by public auction. (West, 1852, p. 158.)

Immediately on his arrival at Hobart Town Mr. Leake set about securing a suitable grant of land. A formal application,

with a letter from the Secretary of State for the Colonial Department, was lodged with the Lieutenant-Governor in the prescribed form, of which the contents were as follows:—

Hobart Town, V.D. Land,
1823.

Sir,

Having arrived from England by the Brig *Andromeda* with an Order from His Majesty's Secretary of State for the Colonial Department for a Grant of Land proportioned to the Means that I possess for its cultivation and improvement, which Letter I have lodged in your Office, I beg leave to subjoin a Statement of the property which I bring with me, and which I intend to employ exclusively for that purpose, and to add that I am prepared to verify my Statement in any way that may be required.

I have the honour to be,
Sir,
Your most obedient humble Servant,
JOHN LEAKE.

To
The Secretary to His Honour
The Lieutenant-Governor,
V.D.L.

Upon this application, a Letter of Location was issued in the following terms:—

Colonial Secretary's Office,
1823.

To John Leake.

Sir,

In reply to your application for a Grant of Land, I am directed to acquaint you that the Lieutenant-Governor has been pleased to order a Location of 500 acres to be made to you upon condition of your cultivating and improving the Land and residing thereupon.

When you have decided upon the Tract you wish to obtain, you will communicate with the Surveyor-General upon the subject, to enable that officer to furnish a description of the boundaries for the approval of His Excellency, and an Order will then be issued from this Office to authorise your occupation of the Land.

I am, Sir,
Your Obedient Servant,
W. B. HAMILTON,
Acting Colonial Secretary.

The next step was to select the land, and we find Mr. Leake setting off up-country on horseback, and with a bullock-cart, the usual mode of conveyance at that time, to explore; leaving his wife and children in rooms at Derwent Park.

In a letter, dated 19th July, 1823, he writes to his wife:

> 'We are all well, and have fixed on our land at the junction of the Macquarie and the Elizabeth. . . . Our cart upset on the road and broke the rum bottle, but did no other material damage. . . . We are at present at the Government Hut, our bullocks having strayed away, but I trust we shall find them to-morrow. We are within two miles of our land, and shall make all the speed we can with our building. . . . I think you will like this part of the country, and shall feel most anxious to get the family up here.'

Enclosed with this letter there is a sketch plan of the situation of the area selected.

The cost of hire of the horse for this expedition was £15. On his return to Hobart Town some weeks later, two assigned servants, 'Government men,' as they were then called, were secured, and added to the establishment, and fifty ewes and lambs at a cost of £1 per head, and in August Mr. Leake started off again for Campbell Town, distant ninety miles or so, this time on foot, and accompanied by his son Robert, aged about fifteen. On the way he sends by messenger a letter from Tin Dish, 21 miles south of Campbell Town, from which I quote the following:

> 'Robert walks very stoutly. We came yesterday from Watson's at Bagdad to Mr. Pike's at 14 Tree Plain, a distance of 26 miles. He was quite fresh. To-day we have come but 15 miles. Our sheep are about 4 miles before us. . . . As soon as our land is measured and I have got business into a proper train, so that our work may go forward in my absence (which I think will be very soon accomplished), I shall return and fetch you all up. The roads are very good now, and it is pleasant travelling, and I trust it will be so much warmer that we may bush it on our journey.'

By September the first hut was finished, and a start had been made with a second for the assigned servants. Crops had been sown and a garden laid out, and planted with the seeds brought from England. One of the boys was shepherd, and another baker and cook. Mr. Leake himself did the washing, as he writes: "This is my washing day . . . I have eight sheets already "firsted," as you call it; they will be clear washed and rinsed in the River . . . it makes them a beautiful colour.' He also says that one of the boys had only two shirts, which were very dirty.

Wages for assigned servants were, for males, £10 per annum, and for females, £7. The latter were often unsatisfactory, as will be seen from the following extract from a letter written by Mrs. Leake not long after she had settled at Rosedale:

> 'I do not think I shall be able to keep the woman servant. She goes about her work very unwillingly and inactively. I have to look after her quite as much as I should any man servant. She has been taking upon herself to say she should go away—I believe she said "run away." I have been obliged to give her a severe reprimand. This morning she told me you had said she was to have more than seven pounds per year; that you had promised it to her. I do not think her worth any more, but I do not think I shall be able to keep her, and am very sorry she was ever sent. She asked me for shoes to-day, and had never, till you mentioned it, said the cloak had been

given in advance. As you said she was such a treasure I endeavoured to consider her as such, and treated her very kindly, but too much lenity will not do for these prisoners . . . I do not think women servants are suitable up the country, unless you need them for sickness or have a family of young children to look after . . .

You will tell me exactly what you gave the woman to understand about her wages, because we do not give the men more than ten pounds a year, who do more work than the women. We cannot expect them to be satisfied if she is given more than her allowance. She tells me she told you she would not come for seven pounds a year, but I do not see how a Government woman has the power of dictating.'

In October, 1823, the household were alarmed by some people lurking about the premises, but a party of soldiers arrived from Norfolk Plains in disguise, looking for them, and they decamped without actually attacking the house.

We get a glimpse of the loneliness of bush life in those days from two letters, written in 1824, to Mr. Leake by Mr. William Pike, of Park Farm, from which I quote the following extracts:

'You have no doubt heard that 14 Bushrangers escaped from Macquarie Harbour, and landed in the Derwent, committing burglaries and robberies wherever they go. I am happy to say that five are taken, one has given himself up, and one has been wounded. The remaining seven are in the bush; the most reasonable supposition was that they had made for the Big Lagoon in our immediate neighbourhood. Parties of soldiers and constables have been here on the look out for some days, without success. We have been preparing to give them a warm reception, should they come in the night. I hope our prowess will not be put to the test. You have doubtless heard of the murder of a settler in our neighbourhood by the natives. They get excessively treacherous. Should they ever come near you, let no insinuation of theirs induce you to appear friendly; I am warranted in this remark by this murder.'

About 18 months after this another gang of bushrangers was in the vicinity, and we find Mr. Willis, of Wanstead Park, writing to Mr. Leake as follows:

'March 12, 1826.

Sir,

In obedience to the command of His Excellency the Lieutenant-Governor, I have to entreat the favour of your friendly co-operation with me in exerting our utmost vigilance in the capture of the broken ranks of Brady's party. Brady, I am happy to say, is taken, with Cody, Bryant, and Goodwin. It is supposed they

are lurking in the Forest; by prompt measures there is every hope of the whole being captured. I beg your immediate attention at my house with as many armed men as you can conveniently spare.'

Shortly after Mr. Pike's warning to beware of the natives a party of them was encountered on Rosedale, as narrated in the following letter, written by Mr. Leake, and dated 19th August, 1824:

'I have been now resident upon my farm in the centre of the island upwards of twelve months, and, though the native hordes, as we have observed by their fires upon the neighbouring mountains, have frequently been within the distance of a few miles, they have but once approached my dwelling. This happened about the month of March last. I was walking alone by the side of a new fence, which enclosed my arable ground, about 200 yards from the house, and was struck with astonishment to see four black figures sitting together on the ground, on the other side, with their feet in a hole, in which one of the posts was inserted, and which had not been quite filled up. I had scarcely recovered from my surprise before they all arose and discovered themselves to be four of what (in this case) cannot be described "the fair sex," and I as improperly accosted them in German . . . to which they replied with an unintelligent grin. Recollecting myself, I had recourse to signs, and putting my finger to my mouth, I said, "Bread? Bread?", when they nodded their approbation, upon which I signified by my hand that they should remain where they were whilst I went to fetch them some food. I soon returned with a loaf, and brought Mrs. Leake and some of the children with me to see them. We gave to each of them as much as they would eat, having understood that they never would divide anything they got with each other. We made various efforts to make ourselves understood, but to little purpose, and found when they spoke to each other that we could not catch any articulate sounds of their language, but they had evidently learned the word "Bread," and also "Tate" (Potatoes), from some previous intercourse with the English. After we had satisfied our curiosity, it being also dinner time, we left them munching their bread, and Mrs. Leake said, "Good bye, good bye." They repeated, and, mistaking it for an invitation to the House, they all suddenly leaped over the rails to come with us, but as they were very dirty in their persons, and had, besides, a kind of itch upon them, we were obliged to decline the honour of a nearer approach, and signed to them to remain as before. In a short time I returned, and brought with me a painted picture of the various costumes of the inhabitants of the earth, which I had brought from Hamburg . . . They appeared amused, and pointed to several

figures, among which those of the greatest variety of colouring seemed to claim their chief attention. The border was also much admired, and one of the girls ran her finger with great pleasure all round it. They however seemed to restrain the expression of their curiosity within due bounds, as persons who could not be thought to be too much excited, and were therefore cautious of manifesting an ignorant and savage wonder. But when I rolled up the scroll quickly it quite got the better of their caution, and they all burst out into an involuntary laugh at this piece of ingenuity. As it was drawing on towards evening, I pointed to a small shepherd's hut close by, of which they took no notice, and seeming still unsettled, and having reason to suspect that a camp of men might be at no great distance, whose presence might be very inconvenient, if not dangerous, we entered into a kind of treaty with them, and gave them a quantity of raw potatoes, on condition of their going away, which they punctually observed, and went gaily off, singing and dancing as they went. Notwithstanding this manner of behaviour, I am of opinion these women come about as spies for the men, who, as you may have seen by our paper, deal very treacherously, and take every opportunity to spear a white man when it is in their power. I even saw one of the women, at a time when she thought herself unobserved, using violent gestures, and, as I thought, cursing the ground, but it might be all imagination. No doubt, however, they look upon us as intruders.'

In 1825 Mr. Leake was granted a further 2000 acres, which he rather naïvely states was 'a mark of the Governor's favor which perhaps I should not have obtained had I not been under his frequent notice.'

In 1829 the Derwent Bank was established in Davey-street, opposite the present Lands and Works Offices, and Mr. Leake accepted a temporary position there as accountant, which necessitated his living in Hobart Town, and leaving the management of Rosedale to Mrs. Leake. Prices for all farming produce and stock were then very low, sheep being sold for nine or ten shillings. It was therefore necessary to add to their income, and it was desirable, for other reasons, to have one of the family in the Capital. There was a good deal of trouble about that time with sheep-stealing, and what with that, and other troubles, poor Mrs. Leake felt greatly the responsibility and isolation. She writes in 1828: 'I think it very long to look forward to your return. I never felt more lonely in my life. I am at times almost melancholy.' Indeed, we can only marvel at the heroism of these women, many of them women of culture and refinement, uprooted from the

sheltered existence they had enjoyed at Home, cut off from all the amenities of society, and planted in the bush among convict servants, bushrangers, and natives, and deprived of most of the ordinary comforts of life.

In a letter written from Hobart on 30th January, 1828, Mr. Leake says:

> 'I have seen two murderers executed to-day, and on Sunday I heard a sermon from the Archdeacon. The text was the sixth commandment, "Thou shalt not kill." Wherein he traced the rise of uncontrolled passion to obstinacy in youth, and shewed how, step by step, men arrived at the commission of crime. Let my dear Edward and Robert beware of despising reproof, nor think it a light thing to begin, by any act of disobedience to parents (or hereafter to masters), a career which could possibly lead towards such terrible results.'

In January of that year he gives us a glimpse of Hobart society:

> 'You ask what sort of people I have to do with. In primis, there is the Sheriff, Dudley Fereday, Esq.[1] He is a bachelor, with a broad Brim, dressed almost as plainly as a Quaker, and very regular and methodical . . . His house is very neat, and yet very plainly furnished, and I observe he sometimes dines in his butler's pantry, and sometimes in his kitchen . . . I breakfast at eight, lunch at one, dine at five, and drink tea at nine. Mr. Lee Archer, the Government Architect, Mr. Ferrar, Collector of Customs, Mr. Wedge, a surveyor, and a few others, are our daily party. No drinking or rioting, and the table open to ladies and gentlemen, the same as the boarding house at Scarborough.'

In April there was a ball at Government House, which is described as a very splendid one, but it rained the whole evening, so that the ladies, who had not, in general, carriages, were almost up to the ankles in mud. However, all were much pleased with the entertainment, and quite charmed with the Governor's (Arthur's) politeness, which much exceeded expectations.'

Mrs. Adey (presumably the wife of the cashier of the Derwent Bank), writing to *The Morning Herald* in 1827, draws rather a different picture of social life in Hobart Town at that time, at any rate in official circles, and of the atmosphere of Government House:

> 'The official corps,' she says, 'are punctilious; fearful of compromising their rank; all etiquette. Entertainments at Govern-

[1] Dudley Fereday, Sheriff, is described by West (p. 129) as 'The most distinguished money-lender, whose ordinary charge was 35 per cent., or less with ample security. After a few years he returned (in 1834) to England, having realised £20,000 by usury. On his death he bequeathed a portion of his wealth to Oxford, to found a scholarship. Mr. Gellibrand applied to him with aptitude 'Burke's phrase, "His bible is his bill-book, and his gold his god."'

ment House are ceremonies rather than parties of pleasure. As the servant opens the door he seems to say, "You may enter, but don't speak." Some more daring spirits would venture a remark, as ballast is thrown out to send a balloon above the fogs; but caution, like Sancho's physician, interdicted the perilous indulgence, and restored the watchful silence. No Dutchman would willingly endure the Humdrumstadt on the Derwent, notwithstanding its natural advantages and commercial promise—a town without a library, and where the common spirit of detraction was exasperated by competition for those favours the Governor could refuse or transfer. The presence of power was everywhere felt; and dreaded wherever it could not be defied.' (West, 1852, p. 115.)

We find a reference to Sir John Franklin in a letter dated 6th July, 1837, in which Mr. Leake says:

> 'I fully intended returning to-day, but as Sir John Franklin arrived I remained to attend his levée, and had the pleasure of being introduced to him by Capt. Montague at Government House. He appears to be a very affable man. He is rather low in stature, but stout and manly in his deportment.'

Soon after their arrival both Sir John and Lady Franklin held levées. I came across the following description of the ladies' levée in another old diary of 1837:

> 'Some of our Methodist ladies were present. Mrs. Dunn from her carriage was presented, dressed in a black satin dress with short sleeves and white net over them, a black headdress with three white plumes, and black satin shoes.
>
> 'Mrs. Orton wore a black satin dress, short sleeves with net over, headdress, and satin shoes.
>
> 'Miss Orton a pink satin slip, with white net over, white satin shoes, and head finely dressed.
>
> 'Sarah ——, more in character, walked there in plain black silk dress and Quaker bonnet, in consequence of which she rendered herself very conspicuous, and formed a subject of conversation to the whole Town.
>
> 'I am told the Justice Pedder's lady became so much annoyed at length with the kind of company that she left Government House in disgust, and went home.'

Evidently human nature has not changed much from those early days!

And now, having seen our settlers fairly started on their new life it is time to take leave of them. It would be beyond the scope of this paper to follow their fortunes further, though the later letters and papers afford us enticing glimpses of people and events which

have long since passed into history, and which make us wish to linger. A procession of Governors, from Sir George Arthur to Sir William Denison, passes across the stage: we see the sons of settlers presenting a formal petition to the Governor, protesting against the discontinuance of grants of land: we find a circular, dated 11th June, 1841, asking for subscriptions towards the establishment of a school in memory of Archdeacon Hutchins, with a list of subscribers, headed by Sir John and Lady Franklin: another circular, dated December, 1843, appealing for funds for the completion of Trinity Church, 'the roof of which was then nearly finished': a lengthy memorandum setting out the views of landholders against the cessation of transportation, which was the subject of such violent agitation: a document surrendering to the Crown an area of land at Risdon for the purposes of a bridge across the Derwent (which, after the lapse of over 80 years, is still unbuilt); the passing of an Act to authorize the construction of a road to Brown's River along the banks of the Derwent: a petition to the Queen, praying for the establishment of a Legislature to be elected by the people; and many other references to matters of public interest, on which time will not permit me to dwell.

On the purely personal side, we see Mr. Leake extending his holdings of land and of flocks and herds, and gradually being appointed to offices and duties of a public nature; and finally becoming a member of the Legislative Council: his sons crossing to the mainland, to find wealth and prosperity during the gold rush: the humble cottage of wattle and daub giving place, first to a modest cottage, and eventually becoming the stately mansion which now crowns the foothills of the Western Tiers.

And, as we pore over the yellowed pages, with their faded caligraphy, there emerges from the mists of the past a vision of high endeavour, of dauntless courage, and of unswerving faith, which stirs our hearts, and fills us with gratitude, admiration, and pride.

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Soundings in Fathoms : Heights in Feet.

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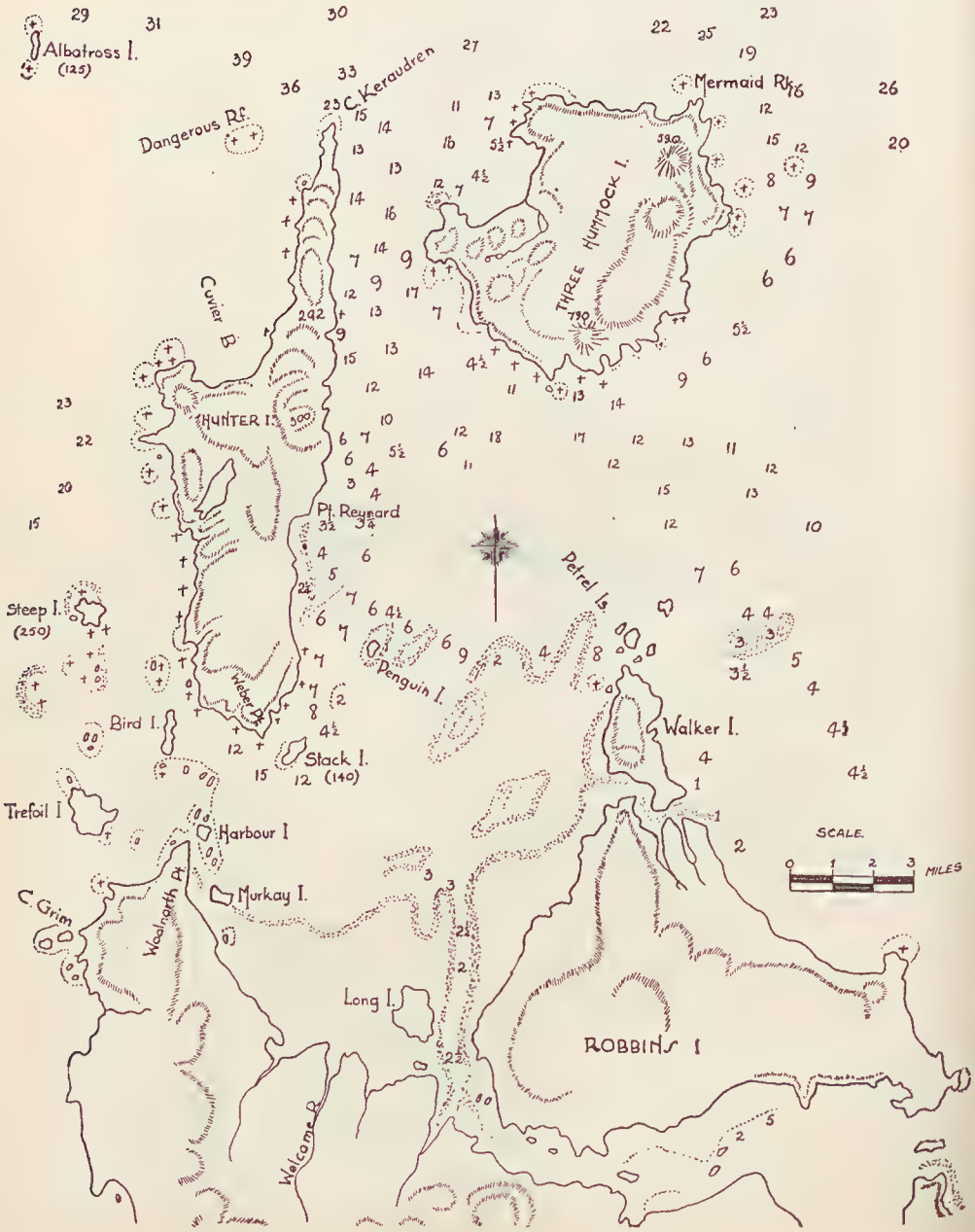

Observations on Visits of the Tasmanian Aborigines to the Hunter Islands

By

A. L. Meston, M.A.

(Read 30th September, 1935)

The Hunter Islands lie off the north-western extremity of Tasmania and cover a considerable area. The principal islands of the group are Robbins, Hunter or Fleurieu, and Three Hummock. In addition there are many smaller islands, islets, and rocks, the chief of which are Trefoil, Bird, Stack, Steep, Penguin, Walker, the Petrels, and Albatross. This group of islands was discovered and named by Flinders in 1798, when he and Bass circumnavigated Tasmania in the sloop *Norfolk*. Landing on Three Hummock, they were surprised to find upon the shore 'several deserted fireplaces strewed round with the shells of the sea ear'. (Flinders, 1814.) This puzzled Flinders, for he thought that the natives were entirely ignorant of the art of navigation.

In August, 1934, Mr. Roy Harvey, of Devonport, made it possible for me to visit the group in his fishing-boat. On both Hunter and Three Hummock I found abundant traces of aboriginal visits.

Hunter, or Barren Island, as Flinders named it, is separated from the mainland of Tasmania by a strait 3 miles wide. It is a narrow island, 14½ miles long, running north and south, and has an area of 21,000 acres. The northern part is very barren, but in the south the soil is better, and the hills are wooded. All around the coast I found small heaps of shells, the remnants of many an aboriginal meal. On the western side, in a sheltered corner in the southern part of Cuvier Bay, there were some well-grassed middens. At Reynard Point, on the east coast, there is a large cave in a slate cliff. This cave is 20 yards wide at the entrance, runs back into the cliff for about the same distance, and is everywhere lofty. It is perfectly dry, provides excellent shelter in all weathers, and is well lighted. From the entrance there is a splendid view to the south. The abundance of shell remains and two deserted fireplaces, a large one in the centre of the cave, a smaller one not far from the end, give ample evidence that this was a favourite haunt of the aborigines.

I purposed to visit Stack Island, where a few years ago the complete skeleton of an aboriginal woman was found, but the wind veering to the east with that disconcerting suddenness which is characteristic of the region, we were forced to run across to Three Hummock Island and lie there. The easterly weather continued for three days, when the wind suddenly chopped round into the north-west and blew a hard gale, forcing us again to run for shelter. The continuance of rough weather made a visit to Stack utterly impossible.

Three Hummock Island lies to the eastward of the northern portion of Hunter Island, from which it is separated by a passage 2 miles wide, with depths from eight to twenty fathoms, deep water extending very close inshore on both sides. Three Hummock is roughly oval in form, and is much more fertile than Hunter. Its area is 23,000 acres. Open downs run out to a well-wooded ridge in the east, which rises into three conical-shaped hills, the highest of which, that in the south, reaches 784 feet. It is from these hills that the island takes its name. Here, as on Hunter Island, I found the relics of many aboriginal feasts. In the sand-blows, bones of marsupials and birds were associated with shells, and shell heaps here and there all round the coast were common.

On both islands game is plentiful, and there is an abundance of fresh water. But, as Flinders pointed out, the small size of the islands renders 'the idea of fixed inhabitants inadmissible', for a permanent occupation would soon exhaust the game and deplete the supply of shell-fish. It was, however, not the abundance of wallaby, opossum, crayfish, and shell-fish that induced the aborigines to visit the islands, but the mutton-bird rookeries. On both Three Hummock and Hunter, as well as on the smaller islands, mutton-birds breed in great numbers. Flinders has left us an account which reveals, in no uncertain way, the vast numbers of these birds at the western end of Bass Strait in 1798, at a time when the aborigines roamed freely throughout Tasmania.

As the *Norfolk* lay at anchor off Three Hummock Island a stream of mutton-birds came from the southward. This stream Flinders reckoned was 300 yards or more in breadth and from 50 to 80 yards in depth. For a full hour and a half the flight continued. The birds were not scattered, but were flying as compactly as a free movement of their wings seemed to allow. 'Taking the stream to have been 50 yards deep by 100 yards in width,' he writes, 'and that it moved at the rate of 30 miles an hour, and allowing 9 cubic yards of space to each bird, the number would amount to 151,500,000. The burrows required to lodge this quantity of birds, allowing a square yard to each burrow, would cover more than 18½ square miles of ground'.

Mutton-birds (*Puffinus tenuirostris*) arrive at the islands towards the end of September. The nesting burrows are first cleaned out, then the birds leave for sea again, returning on or about the 25th

November, when the laying season begins. Only one egg is laid. This takes about eight weeks to hatch. The young birds are unable to fly before the end of April.

To-day mutton-birding is an important industry on the islands at both ends of Bass Strait. The young birds are taken, salted, and exported in thousands to Hobart, Launceston, and Melbourne, where they find a ready sale as an article of food. When salted, the flesh of the bird may not appeal to all tastes, but fresh, it is delicious. The habits of the mutton-bird would be as well known to the aborigines as to us. No wonder, then, that they sought to avail themselves of this bountiful food supply. Once at the rookeries they had no difficulty in getting as much food as they required with little effort. Not only were they able to get the food easily, but the eggs and the flesh of the nestlings provided a pleasant change from the usual diet of shell-fish and marsupials.

As mutton-birds do not breed on the mainland, the aborigines were obliged to cross to the islands. This is no easy matter. Although only 3 miles separate Weber Point, the southern tip of Hunter Island, from Maundy Point (Woolnorth), the crossing bristles with difficulty, and to make it requires sound seamanship. Through this waterway there is a tremendous tide-rip. At springs it attains a velocity of 5 knots, and 3 knots at neaps. At no part of the seaway between the islands and the mainland is there less than a 2-knot current. Nor does the tide ebb one way and flow another. The top half sets westward and the bottom half eastward. In other words, the west-going or flood stream begins at from four and a half to three and a half hours before high water, the east-going or ebb stream begins from three to three and a half hours after high water. So strong is the tidal stream, that near the great number of rocks, reefs, and sunken banks heavy races are formed, and in the channel many swirls and eddies. Even a slight breeze causes a steep, ugly sea, and demands expert seamanship. And it must be remembered that in this vicinity calm weather is rare.

It is sometimes maintained that the aborigines crossed from the mainland to these islands by swimming, but I regard this as an impossibility. Often have I watched the tide setting through the strait, but never, even on a calm day, have I seen conditions favourable for swimming the 3-mile waterway, even by a very powerful swimmer. To get across, a serviceable boat is necessary.

It is well known that the aborigines crossed to Maria and Bruni Islands; and Flinders relates that, as the *Norfolk* passed between the Maatsuyker Islands and the mainland, he 'saw with some surprise, for it is three miles from the main, that its grassy vegetation had been burnt'. As many artifacts have been found at Tasman Island, it is clear that the aborigines also visited it, and, from the nature of the coast-line, this would entail a voyage of six or seven miles.

When James Backhouse, visited Macquarie Harbour, in June, 1832, he was informed by the pilot at the Heads that the aborigines 'cross the mouth of the harbour on floats in the form of a boat, made of bundles of the paper-like bark of the swamp Tea-Tree, lashed side by side by means of tough grass. On these three or four persons are placed, and one swims on each side, holding it with one hand'. (Backhouse, 1843, p. 58.) He was told also that, three months earlier, five boats had gone across in this way, and among the party were several children. (Walker, 1902.) This method of propulsion is eminently suitable for short stretches like the entrance of Macquarie Harbour, where, at slack water, the crossing could be speedily made, but it would not suit the Hunter Passage, which steam-driven vessels can use only with the utmost caution.

Many of the early visitors to these shores and a number of the early inhabitants saw native boats, but very few took the pains to describe them.

In his diary, under the date 21st June, 1804, the Revd. R. Knopwood, telling of Mr. Collins[1] return from the Huon, where he saw many natives, writes: 'He see three of their cattemerans or small boats made of bark that will hold about six of them'. In 1827 a party, of whom Jorgen Jorgensen and Clement Lorymer were the leaders, journeyed down the west coast of Tasmania. At the mouth of the Pieman they 'saw a number of catamarans, on which the aboriginals are in the habit of crossing the river'. West (1852) reports that Lieut. Gunn found at Maria Island, and preserved for several months, a catamaran sufficiently tight and strong to drift for 16 or 20 miles; each would convey from four to seven persons. Although the term 'catamaran' is used on many occasions to describe the Tasmanian aboriginal craft, the name is not of much service to us, for it is indiscriminately used for log rafts, outrigger canoes, or primitive reed or bark floats.

From the various descriptions given, the Tasmanians apparently constructed two different kinds of craft. For the best description of one kind we are indebted to Freycinet, who was with Baudin's expedition which visited D'Entrecasteaux Channel in 1802. 'We have seen and measured several of them', he writes, 'which were of the same size and put together in the same fashion. Three rolls of Eucalyptus bark form one body. The principal roll or piece was 4 m. 55 cm. [14 ft. 11 in.] long by 1 m. [3 ft. 3 in.] broad, the two other pieces being only 3 m. 90 cm. [12 ft. 9 in.] long by 32 cm. [12½ in.] broad. These three bundles which bore a fair resemblance to a ship's yards were fastened together at their ends: this made them taper and formed the whole of the canoe. The scarfing was made fairly compact by means of a sort of grass or reed. So completed the craft had the following dimensions: length inside 2 m.

[1] Lieutenant-Colonel Collins, the Governor of the Colony.

95 cm. [9 ft. 8 in.]; outside breadth 89 cm. [2 ft. 11 in.]; height 65 cm. [1 ft. 3½ in.]; depth inside 22 cm. [8½ in.]; thickness at the ends 27 cm. [10½ in.]. Five or six savages can get into these canoes but generally the number is limited to three or four at a time. Their paddles are simple sticks of from 2·50 m. [8 ft. 1 in.] to 4 m. [13 ft.] or even 5 m. [16 ft. 3 in.] long by 2 cm. [¾-in.] to 5 cm. [2 in.] thick. Occasionally when the water is shallow they make use of these sticks to propel themselves as we do with poles. Generally they sit down when working their canoes, and make use of a bundle of grass as a seat; at other times they keep standing. We saw them crossing the channel only in fine weather. . . . They always place a fire at one end of their canoes, and, in order to prevent the fire from spreading, they place underneath it a sufficiently thick bed of earth or cinders'.

At Maria Island he saw more canoes of the same shape. The only difference was 'that instead of the bark of the eucalyptus trees they used nothing but a kind of reed which grows in abundance at Oyster Bay'. (Freycinet, 1816.) The construction of such boats shows considerable ingenuity in utilizing unpromising material. The grass and reeds used to caulk the gap between the two upper bark rolls and the lower one must have been quite effective, for, as Freycinet tells us, the boat was sufficiently watertight to carry a live fire. Notice, too, how skilfully the bark was streamlined into boat shape, so that the craft was sharp at bow and stern, or, as Calder expresses it, 'something like a whaleboat'. Such boats were first constructed many thousands of years ago, and the knowledge of building them was brought to Tasmania by the aborigines as part of their acquired skill when they migrated hither. The earliest evidence we have of such a canoe comes from Egypt, where we find them figured on painted jars of the Middle Predynastic period, that is, between 4000 and 4500 B.C. Similar boats are still used on Lake Tana in Abyssinia, on Lake Chad in Tropical Africa, in South Africa, and in Peru. Bonwick (1870, p. 51) quotes the description of Mr. Roberts, formerly of the Bruni salt works: 'They were of thick bark interlaced like a beehive with Corrijong bark string, and were strong enough not only to carry men across that stormy sea, but even, on the Southern Ocean, to De Witt and other islands which were visited by the Natives on sealing excursions. The head and stern were raised high above the water like horns. Each boat would hold from four to six men. Long sticks or spears, or bark paddles[1] plied first on one side, then on the other, supplied the place of oars and propelled this rude contrivance as quickly as an English whaleboat'.

Labillardière (1800), who visited Tasmania with D'Entrecasteaux in 1792, thought such craft as fit only for crossing tranquil water.

[1] Paddles were no doubt acquired from the English.

Freycinet was of the same opinion: but they were giving utterance merely to what they thought. The seaworthiness of such craft is attested by an old whaler, who told Bonwick that 'he had seen one of them go across to Witch Island,[1] near Port Davey, in the midst of a storm'.

The other form of boat is that described by Amasa Delano (1817), the American skipper and owner of the whaler *Pilgrim*. Delano, who visited the Derwent in March, 1804, afterwards wrote an account of his voyages and travels, and made some observations on the Tasmanian aborigines. In the course of his remarks he says, 'I observed at the same time that they had three or four small rudely constructed and ugly shaped canoes with them with two outriggers each'.[2] Delano was a seaman who had sailed round the world and had poked into many odd corners. When he said 'outriggers' he knew what he was speaking of, and what he saw must have had some resemblance to the outriggers seen in the islands of Indonesia. That the Tasmanians had a knowledge of so advanced a type of boat as a canoe with the double outrigger is, to say the least, highly improbable. Lieutenant Charles Jeffreys, however, gives a description which is illuminating: 'The natives selected two good stems of trees about 30 ft. long and placed them about 6 ft. apart, parallel with each other. Cross pieces were laid on these and secured to the stout stem by bark ropes. In the middle a cross piece stronger than the others was securely fastened. The whole was then more or less covered with wicker work. In this way a raft 30 ft. long, able to hold from 6 to 10 persons, would be constructed. By means of paddles it could move on the surface of smooth water with amazing rapidity and safety'. (Jeffreys, 1820.) 'Wicker work' is no doubt a euphemism for a rough interlacing of thin, pliant tree stems, but the general idea is quite clear. What he described was an improved raft made of two logs, placed parallel to each other at a distance apart, with a platform laid on cross-poles between them. This platform did not necessarily cover the whole space between the poles either lengthwise or longitudinally. Jeffreys, it must be noted, says '*more or less* covered with wicker work'. The platform not completely filling the space between the logs would form the 'rudely constructed and ugly shaped canoe' of Delano, and the two parallel logs the floats of the outriggers.

Mrs. Meredith (1852) writes of similar craft: 'They were formed of many little bundles of gum tree bark, tied with grass, first separately, and then bound together in the required form, thick and flat, without any attempt at the shape of a boat or canoe, and not keeping the passenger above water when used, but just serving to float him on the surface. In, or rather on, these the natives sat and paddled about with long sticks or drifted before the wind and tide; and in

[1] This is de Witt Island, the largest of the Maatsuyker Group.
[2] Ling Roth does not mention this description.

calm weather frequently crossed over from the mainland to Maria Island; but on such occasions they provided a little raised platform on the raft, on which they carried some lighted fuel to kindle their fire when they arrived there'. The last sentence throws much light on the apparent inconsistencies in the various accounts of native craft. The natives built to suit their purpose. If a narrow waterway, such as a river, was to be crossed, they used a log or a rough and ready structure of bark or reeds; but, when the occasion demanded, they built something really seaworthy.

The different accounts of native craft prove conclusively two things. First, that the native craft, whether we think of the raft or the canoe, could remain afloat for a long time, and secondly that the natives could drive them along at a fast rate.

That they could make the extremely difficult crossing between the mainland and the Hunter Islands proves them expert and fearless seamen. But it would seem that they were accustomed to perform an even more dangerous voyage. Eight miles north-west of Cape Keraudren, the northern point of Hunter Island, lies Albatross Island, a steep rocky mass. Since the natives named this Tangatema, and left larger islands unnamed, it would appear they sometimes visited it. Here, no doubt, they hunted seals, which frequented this rocky islet in such great numbers that Bass had to fight his way through them when he landed there in 1798. This island, like the Maatsuyker Group, is exposed to the full force of the Southern Ocean. On account of the great swell which breaks upon its rocky shores almost continually, and the strong tide-rips off both ends, it is very rarely visited even by men of our own race in modern craft. Landing there is almost always hazardous, and one must be prepared to slip away at a moment's notice.

In face of such seamanship it seems idle to demand a land bridge for the migration of the aborigines to Tasmania. Even at the present time a boat could leave Wilson's Promontory and cross Bass Strait to Tasmania without once being out of sight of land. The greatest gap, that between Deal Island and Flinders Island, is less than 30 miles. When we remember that Bass, Flinders, and a boy sailed from Port Jackson and explored the coast to the southward in a little vessel 8 feet long, surely we must allow it possible for natives in a boat nearly 2 feet longer to cross from Australia to Tasmania, using the islands as stepping-stones, and having, at most, to make an unbroken run of 30 miles. And the probability is, that when they crossed, the greatest gap was considerably less. Moreover, at each stopping-place there is a permanent supply of fresh water. Had the urge been there, their descendants, the aborigines known to the early settlers, in boats such as Freycinet described, could easily have managed such a voyage.

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The Whales and Dolphins of Tasmania

Part I. External Characters and Habits[1]

By

Joseph Pearson

Whales are mammals which have become entirely aquatic, though there is every reason to believe that they have been derived from land mammals. As in the case of the specialized ichthyosaurian reptiles, the aquatic environment has imposed upon whales a fish-like form; the head passes imperceptibly into the trunk without a constricted neck; the anterior limbs or flippers have lost all external semblance to the typical mammalian fore-limb; and the hind limbs have disappeared, though internal skeletal vestiges still persist. A dorsal fin is generally present, but does not contain skeletal supports as in the case of fishes. The well-developed caudal fin has no skeleton, and differs from the vertical tail of fishes in being prolonged laterally into fleshy horizontal expansions, the flukes. The nostrils (blowhole, single or double) are situated high upon the vertex of the head. The eyes are small, the external part of the ear is almost non-existent and has no pinna. Teeth are generally present at some stage in the life history, but in whalebone whales the teeth disappear before the end of foetal life. The blubber, which is characteristic of whales, is a thick subcutaneous tissue containing fat, and is impregnated with oil. The hairy covering, which is present in all mammals, is reduced to a few isolated hairs in the region of the mouth, and the body is naked and shiny. This group includes the largest animals which have ever lived.

The term 'Tasmanian whale' is a misnomer, as it is only in exceptional, and for them unfortunate, circumstances that members of the Cetacea become stranded. The natural habitat of most whales is the high seas, and they have as a rule a very wide distribution. In fact, no other group of animals, except man, is so cosmopolitan. For the purposes of the present account it has been deemed neces-

[1] The original purpose of this paper was to give a comprehensive account of Tasmanian whales. Owing, however, to limitations of space, it has been found necessary to divide this account into two parts; the first, dealing with the external characters and habits of whales, forming the subject of the present paper; and the second, being concerned with internal anatomy and osteology, which, it is hoped, will find a place in the next issue of this Journal. In a way, this separation may be regarded as a fortunate circumstance, for while a comparatively large number of people may be interested to learn about the external appearance and habits of whales, only the specialist would be interested in the anatomical details.

sary to include in the list of Tasmanian whales only the forms of which some record exists either of their having been stranded on Tasmanian beaches or seen in the adjacent seas.[1]

Whales may be divided into two main groups:—

1. Absence of teeth in adult. Presence of whalebone. Blowhole double. Lower jaw very wide, the halves curving outward and being loosely united in front. Females larger than males .... The Whalebone Whales (sub-order *MYSTACOCETI*)

2. Presence of teeth. Absence of whalebone. Blowhole single. Lower jaw triangular, narrow in front, the two halves firmly united. Males larger than females .... The Toothed Whales (sub-order *ODONTOCETI*)

WHALEBONE WHALES

Sub-order Mystacoceti

The main external characters of this sub-order are given above. There are at least six species of whalebone whales found in Tasmanian waters, namely, the Southern Right Whale, now almost extinct, the Humpback, formerly very abundant, now not so common, the Blue Whale, the Fin Whale, the Piked Whale, and the Sei Whale, the latter probably being a rare visitant to sub-antarctic waters.

All of these whales are hunted for their oil. In the early days of southern whaling the Southern Right Whale was one of the principal objects of capture; now it is almost extinct and is protected under a convention entered into recently by twenty-four nations, including Australia.[2] Later the Humpback formed the main object of southern whaling expeditions, but at the present day the Blue Whale and Fin Whale constitute over 90 per cent. of the catches of most southern whaling stations, the two being caught in nearly equal numbers (Mackintosh and Wheeler, 21, p. 272).

Until recently the whalebone, or baleen, was also valuable owing to its use in ladies' garments. The plates of baleen are suspended from the roof of the mouth, and the frayed edges of the plates form an efficient sieve through which the animal sucks the sea water, and in this way sifts from the water enormous quantities of minute crustaceans, collectively known as 'Krill', which consists principally of *Euphausia superba*.

The period of gestation of the whalebone whales is nearly one year, and the females produce calves every two years. The average size at birth of whalebone whales is from 25 per cent. to 30 per cent. of the maximum size of the adult.

[1] There is every reason to believe, however, that in addition to the forms dealt with in the present paper the following whales and dolphins are to be found in the seas around Tasmania:—*Hyperoodon planifrons, Berardius arnuxii, Cephalorhynchus hectori, Delphinapterus leucas, Grampus exilis, Sousa gamadu, and Tursiops catalania.*

[2] Japan is not a signatory to this convention. This convention also prohibited the capture of immature whales of all kinds.

In southern seas the whalebone whales have a definite migration, generally passing north, so as to spend the winter months near the equator. In most cases the young are born at this period, and this northern migration may be regarded as the *breeding migration.* They pass southward again for the summer, presumably in search of planktonic food, which is more abundant in antarctic waters than in the warmer seas. This is known as the *feeding migration.*

The statement made by whalers that the whales of the genus *Balaenoptera* can remain under water for eight to twelve hours without coming up to breathe is not supported by the facts. Normally a large whale remains below water for five or ten minutes, or in extreme cases as much as forty-five minutes. After having been submerged the whale comes up to breathe, and as soon as the nostrils reach the surface the first process is to expel the deoxygenated air from the lungs. The hot, moist air passing out into the colder atmosphere forms a column or 'spout' containing particles of condensed water. This expiratory process is made with considerable force, and often produces a distinct whistling sound. Thus the whale is said to 'blow'. For some minutes after having come to the surface the whale will go through the inspiratory and expiratory processes several times, and normally may blow two or three times a minute. Eventually when the lungs are completely recharged with a fresh supply of air the whale will 'sound', i.e., it will dive to a considerable depth, the maximum depth being at least 100 fathoms. In sounding the Right Whale, Humpback and Sperm Whale leave the surface in a vertical position, the large tail being the last part of the animal to disappear. In the Fin Whale and other members of the genus *Balaenoptera*, the animal, when about to sound, gradually sinks below the surface in a more or less horizontal position, so that the flukes are not seen standing up from the surface of the water.

The Tasmanian forms of whalebone whales may be distinguished as follows:—

1. No grooves on throat:
   - (i) No dorsal fin .... family *BALAENIDAE* *Southern Right Whale*
   - (ii) Dorsal fin present .... family *CAPEREIDAE* *Pygmy Whale*
2. Numerous grooves on throat .... family *BALAENOPTERIDAE*
   - (i) Flippers nearly one-third the length of the animal .... *Humpback*
   - (ii) Flippers not more than one-eighth the length of the animal:
     - (*a*) Bluish-grey. Whalebone and bristles black .... *Blue Whale*
     - (*b*) Grey above, white below. Whalebone dark-grey striped with white, bristles grey .... *Fin Whale*
     - (*c*) Grey above, white below. Flippers with white band. Whalebone yellowish-white, with bristles of same colour .... *Lesser Piked Whale*
     - (*d*) Bluish-grey above, lighter below. Whalebone black, bristles grey or white .... *Sei Whale*

The Right Whales
Family *Balaenidae*

Head more than one-fourth the length of the body. No dorsal fin. No grooves on throat. Plates of baleen long and narrow.

1. Southern Right Whale

Balaena australis Desmoulins, 1822

This species was described by Desmoulins in 1822 from a specimen from the Cape of Good Hope. In 1843 Gray gave the name *Balaena antipodarum* (and later in the text, presumably in error, *B. antipodum*) to the New Zealand right whale in Dieffenbach's Travels (6). The New Zealand and South African forms belong to the same species.

Distribution. This whale is now almost extinct, though formerly it was abundant throughout the southern seas, mainly between 20° S. and 55° S. (commonest about 35° S.). In this connexion it is interesting to note that Governor Collins, writing to Sir John Banks from Hobart Town in July, 1804, stated that for six weeks the Derwent estuary had been 'full of the whales called by the whalers, the Right or Black Whale'. It is now wholly protected under a recent International Convention of the League of Nations. There is only one species of right whale in southern waters, and it is generally accepted that this species differs from the northern right whales.

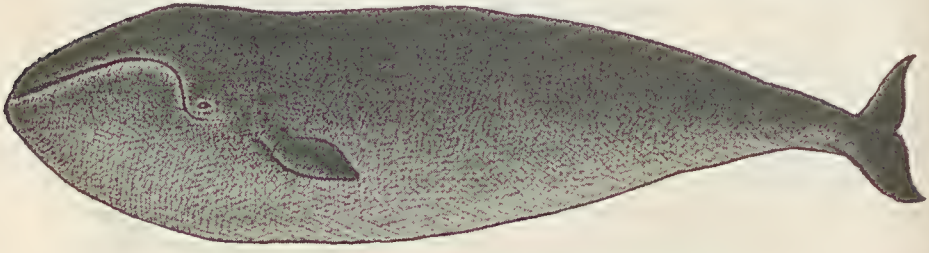

Fig. 1.—The Southern Right Whale (*Balaena australis*)

External Characters. Maximum length, about 18·25 m. (60 feet). No dorsal fin. No longitudinal grooves on throat. Head large, about a quarter the length of the body. *Colour*, generally uniformly black. Sometimes black or greyish-black above, lighter on the ventral surface. *Whalebone*, black, about 200 plates on either side. These plates have a maximum length of about 22·8 cm. (7 ft. 6 in.) No detailed external measurements of this whale are known to me.

Natural History. This species is the 'Black Whale' of the early southern whalers. Dieffenbach (6, Vol. 1, pp. 42-55) gives a detailed account of the habits of this form. Females come inshore in the

winter months to calve. When accompanied by their young the females of this species are easily captured. Males are seldom captured, as they rarely approach the land. This whale blows every 10 or 15 seconds. According to Dakin (5, p. 338) a Southern Right Whale produced an average of 55 barrels of oil, valued at £250.

The Southern Right Whale was formerly fished in the sub-antarctic sea immediately to the south of Australia, in the South Pacific (New Zealand waters, and to the north and west of Chatham Island, on the Coast of Chile Ground, off South America), in the South Atlantic (Brazil Banks and False Banks, the Falkland Islands, off South America, the Pigeon and Tristan Grounds, off the Cape of Good Hope, and the Woolwich (Walfis Bay) Ground), and in the South Indian Ocean (Delagoa Bay Ground, Crozettes Ground, Desolation Ground, and the grounds north of St. Paul). The seasonal migration does not appear to have been very extensive, but on the whole the records show that the whales went north for the winter (July) to a northern limit of 20° S., and migrated south for the summer (January) to a southern limit of 55° S. Most of the whaling was done in the vicinity of the 35th parallel.

For a comprehensive account of ' Black Whale ' fishing see Crowther (4).

Family *Capereidae*

Head about one-fourth the length of the body. Dorsal fin present. No grooves on throat. Plates of baleen long and narrow.

2. The Pygmy Whale

Caperea marginata (Gray, 1846)

Synonymy. This species was founded in the first instance upon the whalebone only. Later, in 1864, the earbone was described separately and a new genus *Caperea* founded. In 1870 the skull, with the whalebone attached, was first described from New Zealand, and Gray, later recognizing the peculiarity of this skull, founded the new genus *Neobalaena*. In 1872 Hector re-examined the New Zealand skull, and found that the earbone agreed with that of *Caperea*. This name, therefore, has priority over the later name *Neobalaena*.

Distribution. Recorded from New Zealand and the southern half of the Australian coast. Probably occurs throughout the Australian portion of the sub-antarctic seas. Apparently a rare species.

External Characters. *Colour*, black above, paler below. Maximum length about 6·1 m. (20 ft.). Body slender. Small head, less than a quarter the length of body. Dorsal fin present. No longitudinal

ridges on throat. *Whalebone* differs from that of any other whale. It is extremely narrow. Ivory coloured, the outer margin having a characteristic dark band. Longest plate examined by me, 78 cm. (31 in.). Width 7 cm. (2¾ in.). Hector (15) records 230 plates on each side in a specimen from Stewart Island.

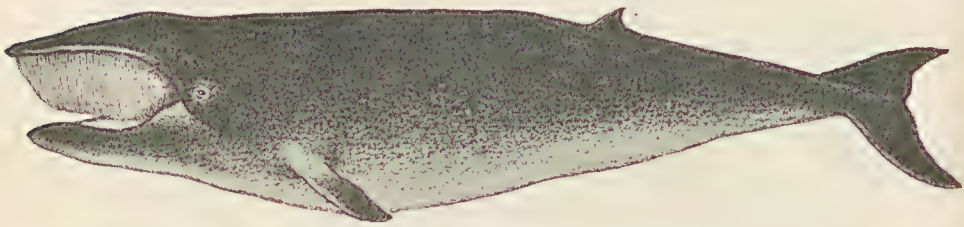

Fig. 2.—Pygmy Right Whale (*Caperea marginata*)

External Measurements, after Hale (12):—

Total length to middle of tail	10 ft. 10 in. (325 cm.)
Tip of snout to eye	21·5 %[1]
Tip of snout to origin of dorsal fin	66·9 %
Height of dorsal fin	3·8 %
Tip of lower jaw to origin of flipper	30·0 %
Length of flipper	10·8 %
Length of gape	20·0 %

Nothing is known of the habits of this form.

The Fin Whales

Family *Balaenopteridae*

Head less than one-fourth the length of the body. Dorsal fin present. Throat marked by numerous longitudinal furrows. Plates of baleen short and broad.

3. Blue Whale or Sulphur Bottom

Balaenoptera musculus (Linné, 1758)

Distribution. Worldwide distribution, but more abundant in the southern hemisphere, and particularly common in antarctic waters. Frequently found in pack ice. Recorded from Australian seas. This form undoubtedly frequents Tasmanian waters.

External Characters. This species is the largest of all whales. Maximum length, 29 m. (95 ft.), the female being slightly larger than the male, fully matured males being about 95 per cent. of the length of the mature females. Dorsal fin very small, and situated three-quarters of the way down the body. Ventral grooves 70-118 (average about 90). *Colour*, uniformly bluish-grey above with lighter mottlings, rather paler below, dark towards the tail. Inner surface

[1] Throughout this paper measurements are given in percentages of the length from the tip of the snout to the tail notch.

of pectorals grey to white. *Whalebone*, coarse and short, entirely black or bluish-black. 270-395 (average 320) plates on each side. Largest plates in the largest whales are 85 cm. (34 in.) long and 60 cm. (24 in.) wide.

External Measurements. The following measurements, taken from Mackintosh and Wheeler (21, p. 276), are the mean measurements of several hundred specimens:—

	Male.	Female.
Tip of snout to posterior insertion of dorsal fin	75·33 %	75·18 %
Tip of snout to eye centre	20·21 %	20·14 %
Tip of snout to blowholes	17·59 %	17·71 %
Length of base of dorsal fin	4·51 %	4·26 %
Height of dorsal fin	1·30 %	1·23 %
Length of flipper (tip to axilla)	9·89 %	9·81 %
Greatest width of flipper	3·67 %	3·65 %

Proportion of head to body increases with age. Thus in a 12·2 cm. (40 ft.) whale the head (tip of jaw to eye) is 15·3 per cent. of total length, and in a 26·5 m. (87 ft.) whale the proportion is 21·2 per cent.

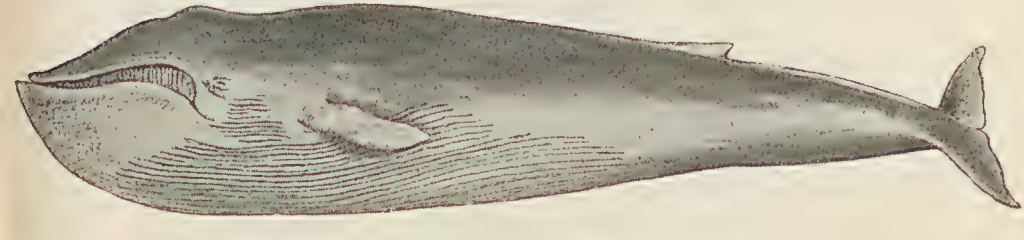

Fig. 3.—The Blue Whale (*Balaenoptera musculus*)

Natural History. This species spouts at intervals of 30 to 40 seconds. The spoutings are vertical and fairly dense and about 12 feet high. When the whale sounds it remains under water 30-40 minutes at the most. The female attains sexual maturity at an average length of 23·5 m. (77 ft. 2 in.) and the male at an average length of 22·5 m. (74 ft. 2 in.) (*International Whaling Statistics*, 1932). Average size at birth, 7 m. (23 ft.), sometimes as large as 8·2 m. (27 ft.). The sexes are about equal in number. The breeding season in the southern ocean is from May to September. Period of gestation, 11½ months. This species is of greater economic value than any other whale. Average yield of oil, 70 to 80 barrels, worth £360 to £400 (the record is 305 barrels). Wood-Jones (32, p. 276) states that the blubber is of poor quality, but Mackintosh and Wheeler (21, p. 272) emphasize the value of this whale, as the yield of oil is proportionately greater than in other whales; in fact, a higher price is paid to whalers for the capture of this species than for any other whale. Harmer (14, p. 109) states that when Blue Whales and Fin Whales are found together, as is usually the case, the former is the preferred object of the chase, as being the more productive animal.

4. The Fin Whale or Finner (Rorqual)

Balaenoptera physalus (Linné, 1758)

Distribution. Worldwide distribution. Fairly common in sub-antarctic waters. Does not usually frequent pack ice. No published record from Tasmania, but undoubtedly this species is found in Tasmanian waters and in Australian seas generally.

External Characters. Maximum length, about 25 m. (82 ft.). The females are larger than the males, the length of male being about 91 per cent. of that of the female. The general form of this whale is proportionately slimmer than that of the Blue Whale, and the pectoral fins are relatively smaller. *Colour*, dark-grey above, white below, the two colours gradually merging. More white colour on the right of underside of the head than on the left. Right lower jaw white, left grey. This asymmetry of colour is explained tentatively by Mackintosh and Wheeler (21, p. 354) as being due to the fact that this whale swims slightly on the right side while under water. Pectorals grey above, light below. *Whalebone*, dark-grey, striped longitudinally with yellowish-white in varying proportions, bristles variable in colour but generally greyish. Anterior third of whalebone on right side white. Number of plates on each side, 270-480 (average 360). The whalebone plates 40-80 cm. (16-32 in.) long, with a mean length of 65 cm. (26 in.), and a width equal to 60-70 % of the length. Ventral grooves 68-114 (average about 85).

External Measurements. The following averages, taken from Mackintosh and Wheeler (21, p. 323), are based upon the measurements of a large number of specimens.

	Male.	Female.
Tip of snout to posterior insertion of dorsal fin	75·55 %	75·17 %
Tip of snout to eye centre	20·87 %	21·00 %
Tip of snout to blowholes	18·86 %	18·94 %
Length of base of dorsal fin	6·00 %	5·65 %
Height of dorsal fin	2·50 %	2·39 %
Length of flipper (tip to axilla)	8·27 %	8·23 %
Greatest width of flipper	2·82 %	2·75 %

Natural History. When the animal sounds it disappears for a maximum period of 10 to 15 minutes. The female attains sexual maturity at a length of 20 m. (66 ft.) and the male at a length of 19·5 m. (64 ft.). Proportion of sexes: males 55 per cent., females 45 per cent. Average size at birth is 21·3 feet. The breeding season in the Southern Ocean is from May to September. Period of gestation 11½ months. This whale is said to reach maturity in 6-8 years, is fully mature at 10 years, and is old at 27 years. Average yield of oil, 35 to 50 barrels.

5. The Lesser Piked Whale

Balaenoptera acutorostrata, Lacépède, 1824

Distribution. Apparently not a common form. Probably has a worldwide distribution. Found in high latitudes in pack ice in the southern summer. Found throughout the antarctic and subantarctic seas.

External Characters. This is the smallest species of the genus. Maximum size about 9·1 m. (30 ft.). Body relatively deeper than in other species of the genus. Head narrow and pointed; the upper jaw fits closely into the hollow of the lower jaw, which projects beyond the upper. Dorsal fin relatively high, the tip being strongly recurved. Flippers small. Body keeled dorsally and ventrally behind the dorsal fin. *Colour*, grey-black above, white below. Flukes grey above, white below. Flippers with white band on the outside. A triangular patch of lighter colour is generally present on either side of the back in the region of the dorsal fin. *Whalebone*, plates and bristles yellowish-white, average 325 plates on each side. Greatest length, 20 cm. (8 in.) without bristles.

External Measurements of a female (after Turner, 30):—

Length	8·6 m. (28 ft. 4 in.)
Tip of beak to posterior insertion of dorsal fin	75·3 %
Tip of beak to blowholes	13·2 %
Length of base of dorsal fin	5·6 %
Height of dorsal fin	3·5 %
Length of flipper (tip to axilla)	9·3 %
Greatest width of flipper	3·8 %

Natural History. Little is known of the habits of this species. It probably has the same migratory habits as other species of the genus. Length at birth, about 2·7 m. (9 ft.).

6. The Sei Whale

Balaenoptera borealis (Lesson, 1828)

Distribution. The natural home of this species is probably in the northern hemisphere. Its appearance south of the equator is spasmodic and its occurrence in the antarctic is rare. Lillie (18) records several specimens from the seas south of Australia in parallels 41° to 44° S. Some of these observations were made not far from the Tasmanian coast, so that we are justified in including this species in the Tasmanian list. There is no record of this whale having been washed ashore on the Australian coast, but specimens have been taken in New Zealand. It has also been recorded south of the equator from the Falkland Islands, South America, and South Africa.

External Characters. Comparatively small size. Greatest length, about 16·4 m. (54 ft.). Average length of mature animals, 14·3 m. (47 ft.). Females slightly larger than males. Dorsal large, high

and falcate. Intermediate in general body proportions between the Blue Whale and Little Piked Whale. *Colour*, variable. Grey, with or without bluish tinge. Ventral surface lighter. The grey dorsal area sometimes continued into a ventral band across the abdomen. Ventral folds white or pink, with the furrows a deeper colour. Ventral furrows 32 to 60 in number. *Whalebone*, deep bluish-black, bristles grey or white, 290-340 on each side. Greatest length 77 cm. (31 in.), greatest width 30 cm. (12 in.).

External Measurements (Andrews, 1):—

	Male.	Female.
Total length	14·5 m. (47 ft. 6in.)	14·6 m. (48 ft.)
Tip of snout to eye	18·9 %	20·1 %
Tip of snout to blowholes	15·4 %	16·6 %
Tip of snout to posterior insertion of dorsal fin	70·4 %	72·0 %
Height of dorsal fin	3·6 %	3·1 %
Length of base of dorsal fin	4·1 %	—
Length of flipper	9·0 %	8·9 %
Width of flipper	2·7 %	2·7 %

Natural History. This whale is now not so abundant as in former times, probably the result of overfishing. Strictly speaking, it is a northern form, and is said to migrate from the northern latitudes about September; it goes as far south as the sub-antarctic, and returns northward about May or June, remaining in northern waters during the summer (June to August). It is not unlikely, however, that many animals remain permanently in the southern hemisphere. The spout of the species is rather diffuse, and ascends vertically to a height of 10 to 14 feet. It blows once or twice a minute, or sometimes as frequently as every 20 seconds. It is said to be the fastest of the larger whales for short bursts of speed, for example, immediately after having been harpooned. It feeds upon *Euphausia* and the Copepod *Calanus finmarchicus*, but is said to feed also on sardines when these are present in the surface waters in large numbers. Period of gestation, 10-11 months.

7. The Humpback

Megaptera nodosa Bonnaterre, 1789

This whale has been given several names since it was described in 1789, partly because the northern and southern forms were considered to be distinct species. There appears to be no justification for such a distinction, and most authorities now regard the humpbacks of the world as belonging to one species.

Distribution. Cosmopolitan. Recorded from all parts of the coast of Australia and from New Zealand.

External Characters. Maximum length, about 16·7 m. (55 ft.), though much larger animals have been recorded. The female is larger than the male, the average length of a mature male being about

90 per cent. of that of the mature female. The external form is very characteristic, and leaves no doubt as to the identity. The body is relatively much deeper than in *Balaenoptera*. The snout and mandible bear a number of hemispherical tubercles. The dorsal fin is low and thick. The flippers are long and narrow, exceeding in relative length those of all other whalebone whales, and the preaxial border of each fin bears a number of protuberances. The ventral grooves are few and broad, 14-30 in number. *Colour*, variable. Normally black on head, back, and sides, but frequently broken up by white lines or patches. The throat, chest, and undersurface generally entirely white, sometimes streaked with black. Flukes black above, white or spotted below. Flippers: upper surface black or streaked black and white, anterior edge white, posterior black. undersurface white. *Whalebone*, dull greyish-black, though some of the anterior plates may be white. Longest whalebone (without bristles), 61 cm. (24 in.). Greatest breadth, 12·5 cm. (5 in.). 400 plates on each side.

Fig. 4.—The Humpback (*Megaptera nodosa*)

External Measurements, given by Chubb (3):—

	Female. 14 m. (46 ft.)	Male. 13·2 m. (43 ft. 6 in.)
Total length (snout to notch in tail)		
Tip of snout to posterior insertion of dorsal fin	70·2 %	68·9 %
Tip of snout to eye centre	23·3 %	27·5 %
Tip of snout to blowhole	—	23·0 %
Vertical height of dorsal fin	3·2 %	2·3 %
Length of flipper from head of humerus	32·6 %	—

Natural History. The Humpback is somewhat slower in its movements than the various species of *Balaenoptera*. According to Lillie (18), it seldom stays under water for more than seven minutes. It shows a distinct partiality for coastal waters. The southern forms

spend the summer in the Antarctic, and migrate northward towards sub-tropical waters in the winter. Thus this whale probably visits Tasmanian waters in the early winter during its northerly migration, and again in the spring on its way back to the Antarctic. The young are born in the warmer waters during the winter months. Period of gestation, about 11½ months. Size of young at birth 4·5 m. (15 ft.). The females are more abundant than the males. This form is becoming less abundant. The beginning of the twentieth century saw the revival of antarctic whaling, and at first the humpback was almost the only whale which was hunted. In South Georgia, for instance, nine-tenths of the whales caught in 1911 were humpbacks In recent years, however, only a small percentage of the whales caught have been humpbacks.

According to Dakin (5, p. 238), a humpback yields an average of 35 to 40 barrels of oil. Crowther (4, p. 132) states that the yield was 6 to 7 tuns.[1]

In early days the humpback was principally hunted in the following parts of the southern seas: Indian Ocean (Mozambique, Madagascar, and N.W. Australia), Pacific Ocean (New Caledonia, Tonga Islands, New Zealand, Lower California, Galapagos, Coast of Chile), Atlantic Ocean (West Indies, Cape Verde Islands, Coast of Angola).

THE TOOTHED WHALES

Sub-order **Odontoceti**

The principal external characters of this sub-order are given above (p. 164).

With the exception of the Sperm Whale, the toothed whales have not the same economic importance as the whalebone whales. The former are, moreover, generally smaller than the latter, the Sperm Whale being the only member of the group which is known to attain the gigantic size of the larger whalebone whales. Unlike the latter, the males of the toothed whales are larger than the females. The presence of teeth accounts for the predacious character of most toothed whales, which generally feed upon fish. The enormous Sperm Whale, however, usually feeds upon cuttlefish, and the Killer Whale is said to be the only whale which will prey upon other whales. It also feeds upon seals and other aquatic mammals.

It cannot be said that our knowledge of the smaller dolphins is very satisfactory. Owing to their small size and negligible economic importance, together with their habit of frequenting the high seas, our precise knowledge of these forms is dependent upon the occasional strandings of specimens. The stranding of a dolphin of small size arouses little or no comment, and consequently only a small per-

[1] One tun = 8 barrels.

centage of such animals come under the notice of specialists, and in most of these cases only the skeleton is available for examination.

Tasmanian representatives of the toothed whales may be divided into three families, as follows:—

1. Functional teeth present only in lower jaw. One pair of grooves on throat:
   (i) Teeth numerous. Blowhole on left side of head. Single nasal passage. Mouth on lower side of head .... family *PHYSETERIDAE*
   (ii) Teeth few. Blowhole median. Double nasal passage. Mouth terminal. Tail not notched .... family *ZIPHIIDAE*
2. Functional teeth present in upper and lower jaws. No grooves on throat. Tail notched .... family *DELPHINIDAE*

The Sperm Whales

Family *Physeteridae*

Members of this group may be distinguished as follows:—

1. Large size. Large, sharply truncated head. Blowhole at tip of snout. 22-26 pairs of large conical teeth .... *Sperm Whale*
2. Small size. Relatively small head. Blowhole at vertex of head. 13 pairs of small recurved teeth .... *Pygmy Sperm Whale*

8. Sperm Whale or Cachelot

Physeter catodon Linné, 1758

It is considered by some that there are distinct northern and southern species, by others that there are two southern forms and one northern. Flower (8) considered that there was no difference between northern and southern forms, and that there is only one cosmopolitan species. This would appear to be the soundest view to take.

Distribution. Worldwide, and recorded on many occasions from Australian and Tasmanian waters. A school of 36 males and one female was stranded on Perkins Island, North-West Tasmania, in February, 1911. Harmer (13) states that this species occurs in all tropical waters, but stragglers, nearly always old males, reach both polar seas.

External Characters. The size of this species has been greatly exaggerated. The male rarely exceeds 18·25 m. (60 ft.), the normal size being 12-15 m. (40-50 ft.), and the fully grown female is about 30 per cent. shorter. The Sperm Whale cannot be mistaken for any other whale owing to the enormous head and sharply truncated snout. The blowhole is single, as in all toothed whales, and is situated near the tip of the snout on the left side, and the 'spout' is directed

forward. The dorsal fin is not well defined, and is represented by a series of humps. There are normally 22-26 pairs of teeth in the lower jaw. These teeth are large and conical. Generally there are no teeth in the upper jaw, but on rare occasions a few pairs of small irregular teeth are found. It was a favourite hobby of old-time whalers to engrave the teeth of the Sperm Whale with portraits of ships, &c. The Tasmanian Museum contains a good collection of such 'scrimshaw' work brought back by Hobart whalers. *Colour*, black above, greyish below.

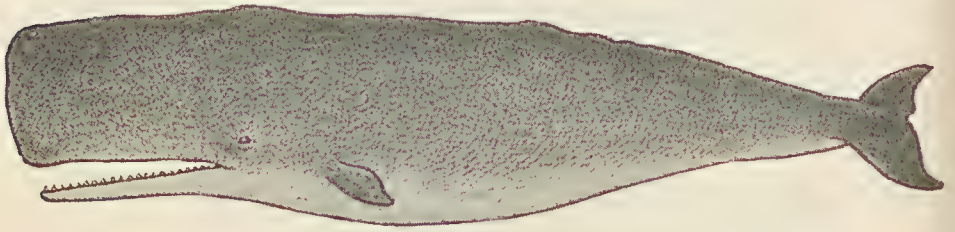

Fig. 5.—The Sperm Whale (*Physeter catodon*)

EXTERNAL MEASUREMENTS of a male (Chubb, 3):—

Tip of snout to notch of tail	16·4 m. (54 ft.)
Tip of snout to posterior insertion of dorsal fin	70·4 %
Length of base of dorsal fin	7·4 %
Tip of snout to eye centre	32·4 %
Tip of snout to anterior insertion of flippers	39·3 %
Length of flipper from head of humerus	8·9 %

NATURAL HISTORY. This species prefers the warmer waters, but passes into higher latitudes in the summer, and usually keeps to the high seas and avoids the land. As a rule, a school consists of several females with one or two males, so that the stranding of a school of whales in Tasmania, all of which, with one exception, were males, as referred to above, must be regarded as unusual. It feeds upon squids. According to an old log-book quoted by Dakin (5, p. 73), if the male is harpooned the cows will desert him. If, however, a cow or calf is harpooned the rest of the school will flock around the wounded whale. The Sperm Whale is very active in spite of its size. It sounds to a great depth, and is said to be capable of remaining submerged for an hour. At one time it was very abundant, and was hunted for its valuable spermaceti, but its numbers have been greatly reduced. The sperm oil is mixed with spermaceti, most of which is contained in the thickened anterior part of the head. This whale is also famous for its ambergris, a pathological secretion of the intestines, which is used in the manufacture of perfumery, and was formerly used as a medicine. According to Dakin (5, p. 238), large males have given as much as 120 barrels of sperm oil, and females averaged 15 to 20 barrels, valued at £250. One sperm whale actually yielded £1600 worth of oil in 1860. Log-book records

dating from 1761 to 1920 show that, so far as the southern hemisphere is concerned, during the months April-September the majority of sperm whales were caught (*a*) in the South Pacific on the equator, also on the Vasquez Ground (sub-tropical) between New Zealand and Fiji, and on the Archer Ground (tropical) and on the Coast of Chile Ground (sub-tropical), off the South American coast; (*b*) in the South Atlantic, mainly on the Carroll Ground, off the African coast; (*c*) in the Indian Ocean, off the African coast, on various tropical and sub-tropical grounds, and the Coast of New Holland Ground, off Western Australia. During the months October-March the records are much more scattered, and show that this species passes southward during these months: (*a*) in the South Pacific still abundant on the grounds already mentioned, but also common to the south of New Zealand, at Chatham Island, also on the Middle Ground between Australia and New Zealand, and more abundant on the Coast of Chile Ground; (*b*) in the South Atlantic abundant down the coast of South America as far as the Falklands, on the Tristan Ground (lat. 35° S.) and Cape of Good Hope, and still abundant on the Carroll Ground; (*c*) in the Indian Ocean, around Zanzibar and Madagascar, and as far south as 40°, and West and South-Western Australia.

Crowther (4, p. 148) gives an interesting map showing the whaling grounds of the Hobart Town whalers. He also gives a detailed historical account of sperm-whaling in Tasmanian ships.

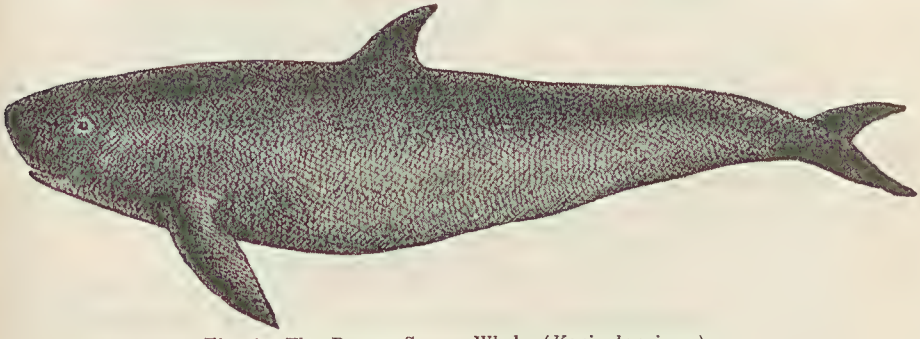

Fig. 6.—The Pygmy Sperm Whale (*Kogia breviceps*)

9. Pygmy Sperm Whale

Kogia breviceps (Blainville, 1838)

Distribution. A rare form, but widely distributed throughout the world, particularly in the southern hemisphere. Not recorded from polar seas. Recorded from Tasmania.

External Characters. Maximum length, 4 m. (13 ft.). Average length of adult, about 2·7 m. (9 ft.). This species is rather delphinoid in appearance. It has a small head and slightly overhanging snout. Dorsal fin is well developed and falcate. The blowhole

is single and placed slightly on the left of the middle line. There are about 13 curved teeth on each side of the lower jaw. Usually no teeth are present in the upper jaw, though there are a few cases on record of one pair being found at the front of the upper jaw. *Colour*, jet black above, white or pinkish-white below, the colours of the two surfaces being clearly separated.

EXTERNAL MEASUREMENTS, after Pearson (24):—

Total length to tip of tail	2·55 m. (8¼ ft.)
Tip of snout to tip of dorsal fin	50·6 %
Height of dorsal	7·4 %
Length of flipper	12·9 %
Tip of snout to front of eye	9 %
Distance between tips of flukes	21·9 %

Practically nothing is known of the natural history of this form.

THE BEAKED WHALES

Family *Ziphiidae*

Tasmanian members of this family may be distinguished as follows:—

1. Conical tooth at tip of lower jaw on each side, at the front of mouth ..... *Cuvier's Beaked Whale*
2. One tooth (laterally flattened) situated about halfway along the gape of the mouth, at each side:
   (i) Teeth strap-shaped in mature specimens, and grow upward around the beak ..... *Strap-toothed Whale*
   (ii) Teeth triangular in side view ..... *Southern Beaked Whale*

10. CUVIER'S BEAKED WHALE

Ziphius cavirostris Cuvier, 1823.

Some authors regard the southern form (*Epiodon chathamiensis* Hector or *Ziphius novae zealandiae* Haast) as being a distinct species. The view taken here, however, is that there is one cosmopolitan species common to both northern and southern hemispheres.

DISTRIBUTION. A cosmopolitan species, which has been recorded from Australia, including Tasmania and New Zealand. It is probably not found farther south than 50° S.

EXTERNAL CHARACTERS. Maximum length, about 8·5 m (28 ft.). Delphinoid shape. Well-defined hump on posterior part of head, over the eyes. Eyes some distance behind the angle of the mouth. Lower jaw underhung and bearing one tooth at each side at the extremity. The teeth of the male are larger than those of the female. In some cases the teeth do not break through the gums. A number of small rudimentary teeth concealed beneath the gums have been recorded in both upper and lower jaws. One pair of grooves joining in front to form a V-shaped groove on the throat. Dorsal fin falcate and situated two-thirds of the distance down the back. *Colour*, head and

anterior portion of back as far as dorsal fin, white; rest of body black. Dorsal fin black, except a narrow white line along the anterior edge. The division between the two colours is well marked except on the cheeks. The colour of this species appears to vary, and a specimen stranded in New Zealand was reported to be dark above and white below.

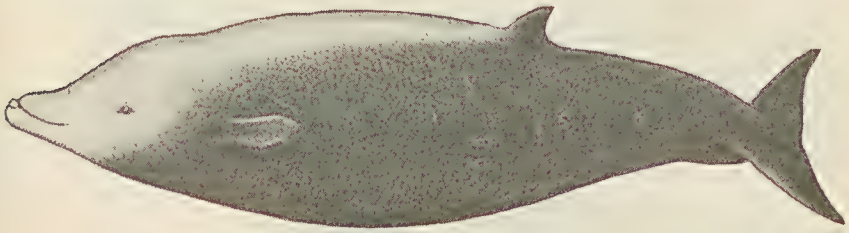

Fig. 7.—Cuvier's Beaked Whale (*Ziphius cavirostris*)

External Measurements, after True (29).
Dimensions of a female whale 5·9 m. (19 ft. 4 in.) long.

Tip of snout to eyes	10·8 %
Tip of snout to blowhole	10·4 %
Tip of snout to axilla	20·0 %
Tip of snout to posterior margin of dorsal fin	67·2 %
Length of mouth	5·0 %
Length of flipper from axilla	8·1 %
Breadth of flipper	2·9 %
Vertical height of dorsal fin	5·2 %
Breadth of flukes	28·0 %

Nothing of importance is known of the natural history of this form. The beaked whales are related to the sperm whales, and have spermaceti.

11. Strap-toothed Whale

Mesoplodon layardii (Gray, 1865)

Distribution. This is a southern form, apparently rare, and has been recorded from Australian waters, New Zealand, Cape Colony, the Falkland Islands, and Tasmania.

External Characters. The only general description of this animal is given by Waite (31), from a specimen stranded near Lyttleton, New Zealand. Maximum length, about 5·5 m. (18 ft.). The dorsal fin is triangular, the posterior border being about vertical. There is a well-defined 'forehead' and a distinct beak. The most characteristic feature is the single tooth growing up on each side from the lower jaw about half-way along the gape of the mouth, arising from the mandible opposite the posterior end of the symphysis. These teeth grow upward and backward, and curve over the beak

in old specimens (probably only in males), nearly meeting above, and thus preventing the mouth from opening to any extent. In immature specimens the teeth are short, and have a long antero-posterior axis. They are triangular in side view, the apex of the triangle being uppermost and forming the cutting surface of the tooth. The throat has one pair of grooves, widely separated behind and converging in front. *Colour.* From a point half-way down the back to the region immediately in front of the flippers there is a line surrounding the body in an oblique direction. Anterior to this line the body is yellowish-grey, with the exception of an irregular black band encircling the forehead and throat. Posterior to this line the animal is black, with the exception of a small greyish area on the ventral side and the tips of the fluke, which are yellow.

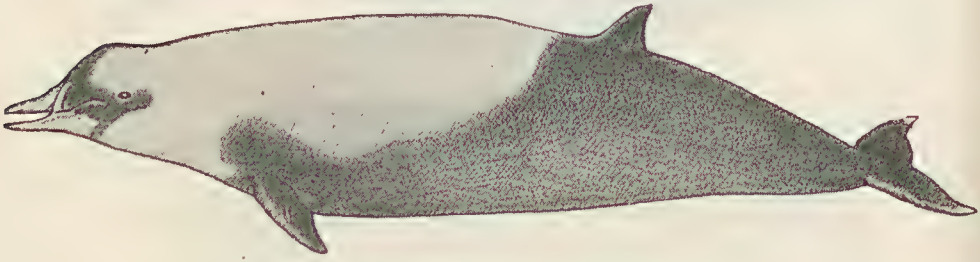

Fig. 8.—Strap-toothed Whale (*Mesoplodon layardii*)

External Measurements of a male, given by Waite (31):—

Total length of animal	5·5 m. (18 ft. 3 in.)
Snout to blowhole	12·2 %
Snout to dorsal fin	60·8 %
Base of dorsal fin	8·2 %
Height of dorsal fin	5·9 %
Length of flipper	11·6 %
Width of tail flukes	26·5 %

Nothing is known of the natural history of this species.

12. Southern Beaked Whale

Mesoplodon grayi von Haast, 1876

Distribution. South coast of Australia. Southern Pacific generally, including New Zealand and Patagonia.

External Characters. Snout pointed and beak-shaped. Flippers small. Dorsal fin falcate. A pair of grooves on the throat. A single tooth on each side of the lower jaw arising at the posterior end of the symphysis, having a position half-way along the gape of the mouth. This tooth is small in young specimens, and may be completely enclosed by the gum. In mature specimens it is large and triangular in side view and laterally compressed. In addition to these functional teeth there may be a series of 17-19 minute teeth on each side of the upper jaw. This row occupies a space of about

10 cm. (4 in.). These teeth are not attached to the maxillae, and come away with the tissues of the gum when these are removed. *Colour*, black all over, sometimes lighter below.

EXTERNAL MEASUREMENTS of a male, given by Hector (15):—

Total length	4·7 m. (15 ft. 6 in.)
Snout to eye	12·3 %
Snout to angle of mouth	8·1 %
Snout to flipper	20·9 %
Snout to dorsal fin	58·1 %
Snout to blowhole	11·3 %
Length of flipper	10·2 %
Height of dorsal fin	4·8 %
Base of dorsal fin	6·4 %

Nothing is known of the natural history of this form.

THE DOLPHINS

Family *Delphinidae*

The Tasmanian dolphins may be identified as follows:—

I. Teeth small. More than 20 on each side of both jaws:
  1. Three teeth in about 15 mm. (⅝-in.) of tooth line—
    (i) With dorsal fin:
      (*a*) Teeth 47-51 ..... *Common Dolphin*
      (*b*) Teeth 35-44 ..... *Slender-beaked Dolphin*
      (*c*) Teeth 28-34 ..... *Dusky Dolphin*
    (ii) Without dorsal fin, teeth 35-44 ..... *Péron's Dolphin*
  2. Three teeth in about 30 mm. (1¼ in.) of tooth line ..... *Bottle-nosed Dolphin*

II. Teeth large. Less than 15 on each side of both jaws.
  1. Three teeth in 80-110 mm. (3¼-4½ in.) of tooth line. Head not globular:
    (i) Three teeth in 100-110 mm. (4-4¼ in.) of tooth line. Colour, black and white ..... *Killer Whale*
    (ii) Three teeth in 80-90 mm. (3¼-3½ in.) of tooth line. Colour black ..... *False Killer*
  2. Three teeth in 45-55 mm. (1¾-2¼ in.) of tooth line. Head globular ..... *Pilot Whale*

13. THE COMMON DOLPHIN

Delphinus delphis Linné, 1758

DISTRIBUTION. Universal. Common in Australian waters. Flower (10) examined a series of skeletons from Tasmania, and stated that they were identical with the English form in every character.

EXTERNAL CHARACTERS. Average length, 2·1 m. – 2·4 m. (7-8 ft.). Body slender. Forehead sloping gradually. There is a distinct beak, which is separated by a groove from the upper part of the head. Dorsal fin triangular, slightly falcate, half-way down the back. Pectoral fin long and narrow. Teeth 46 to 51 on each side of both jaws. One tooth in every 5 mm. of tooth line. *Colour*, variable, generally black above, white or grey below (sometimes yellow in immature specimens). A curved black line outlined

with white runs from the constriction of the beak to the eye. A curved line runs along the side of the body from the eye to the level of the hinder end of the dorsal fin. Above this line the animal is black, below it shades gradually from grey to white. Sometimes the light under-surface is streaked with dark curved lines.

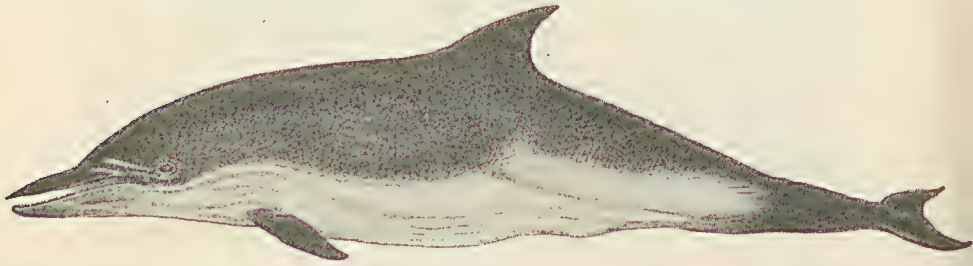

Fig. 9.—The Common Dolphin (*Delphinus delphis*)

External Measurements of a female (True, 28):—

Total length	1·9 m.	(6 ft. 4 in.)
Tip of snout to angle of mouth	14·5 %	
Tip of snout to eye	16·5 %	
Tip of snout to blowhole	18·5 %	
Tip of snout to base of flipper	23·8 %	
Tip of snout to dorsal fin	46·3 %	
Length of flipper	15·2 %	
Height of dorsal fin	9·3 %	
Width of flukes	20·5 %	

Natural History. This species is an active, powerful swimmer, and ascends estuaries for many miles from the open sea. It is frequently seen in large schools, which accompany ships on the high seas and play about near the ships' bows. This habit would appear to be common to many of the smaller toothed whales. The Common Dolphin is a fish eater. The stomach of a Mediterranean specimen contained over 15,000 otoliths of fishes. Scott and Lord (27) found the remains of cuttle-fish and Spatangoid spines. In some European countries the flesh of this dolphin is eaten. In Roman Catholic countries it is classed as a fish, and thus affords a welcome variation in the fish diet on fast days.

14. Slender-beaked Dolphin.

Stenella pseudodelphis (Schlegel, 1841)

Distribution. Temperate and sub-tropical seas of southern hemisphere.

External Characters. Similar to the Common Dolphin in general shape, and probably grows to same size. Teeth 35 to 44 on each side of both jaws. One tooth in every 5 mm. of tooth line. *Colour*, dark above, lighter below.

External Measurements, from True (28):—

Total length (female)	1·75 m. (5 ft. 9 in.)
Tip of snout to dorsal fin	46·6 %
Tip of snout to base of flipper	23·0 %

Nothing is known of the natural history of this dolphin.

15. Dusky Dolphin

Lagenorhynchus obscurus (Gray, 1828)

Distribution. Southern seas as far south as 58° S. Recorded from New Zealand. A skull of this form is in the Tasmanian Museum.

External Characters. Maximum length, about 1·8 m. (6 ft.). There is a well-developed triangular dorsal fin about half-way down the body. This species is not unlike the Common Dolphin in external shape, except that the dorsal fin has a wider base and there is no distinct beak. Teeth small and numerous. 28-34 on each side of both jaws, commonest dentition 32. One tooth in every 5 mm. of tooth line. *Colour*, variable. Normally the back and fins black. (Sometimes the dorsal fin and flippers are white.) Ventral surface

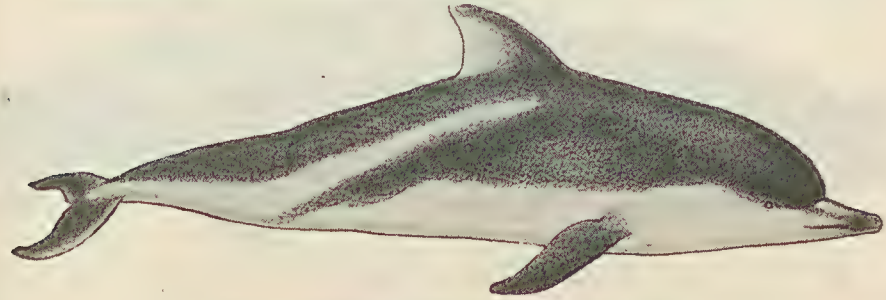

Fig. 10.—The Dusky Dolphin (*Lagenorhynchus obscurus*)

white, an oblique white area invading the dorsal black area immediately below the dorsal fin. Throat white, and this colour may also invade the upper lips. The two colours throughout the body are clearly separated from each other.

External Measurements, after True (28), from a dried skin in the British Museum. The measurements may be regarded as only approximately correct.

Total length	1·6 m. (5 ft. 5 in.)
Tip of snout to angle of mouth	13·4 %
Tip of snout to eye	15·4 %
Tip of snout to blowhole	14·6 %
Tip of snout to anterior base of flipper	25·4 %
Tip of snout to anterior base of dorsal fin (along curve of back)	48·8 %
Length of dorsal fin	13·8 %
Height of dorsal fin	11·5 %
Length of flipper	16·9 %
Greatest width of flipper	5·4 %
Width of flukes	24·2 %

NATURAL HISTORY. Little is known of the habits of this form, but it occurs in large schools which play about the bows of ships, and so far as is known it is found only in southern seas.

16. PERON'S DOLPHIN

Lissodelphis peronii (Lacépède, 1804)

DISTRIBUTION. The few recorded observations of this species limit its distribution between 42° S. and 47° S. in the South Pacific and the seas around Tasmania. The first specimen was captured by Péron in 1802 to the south-west of Tasmania. The second specimen recorded from Tasmanian waters was seen in 1910 by the 'Terra Nova' expedition.

EXTERNAL CHARACTERS. This dolphin has two unmistakeable features, the absence of the dorsal fin and the peculiar colour. The lower jaw projects slightly beyond the upper. There is a groove separating the beak from the forehead, the beak being short and nearly in the same plane as the forehead. About 43 teeth on each

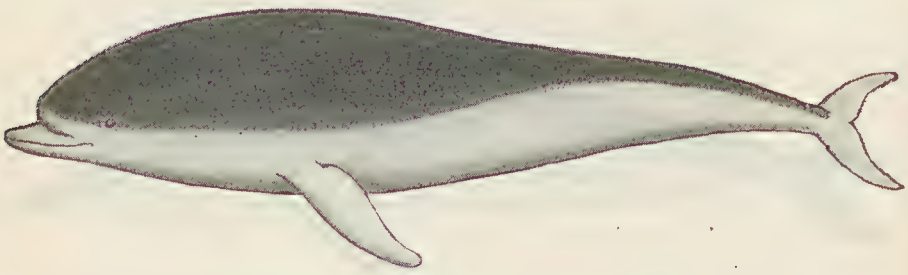

Fig. 11.—Péron's Dolphin (*Lissodelphis peronii*)

side of both jaws. One tooth in every 5 mm. of tooth line. *Colour.* The back is black and the underside white, the separation between the two colours being very pronounced. The black area may or may not invade the tail-flukes.

EXTERNAL MEASUREMENTS, from True (28), after Lesson.

Total length	1·84 m. (6 ft. 2 in.)
End of snout to flipper	32·3 %
End of snout to angle of mouth	14·7 %
Length of flipper	11·4 %
Breadth of flukes	23·5 %

NATURAL HISTORY. This species has been recorded only about half a dozen times, so that little is known of its habits. Lillie (18) records a pair of dolphins belonging to this species as having been seen playing under the bows of the ship. In one case they were in company with a school of Dusky Dolphins, but separate from them, and distinguished not only by their colour and absence of dorsal fin, but also by their larger size.

17. Bottlenosed Dolphin

Tursiops truncatus (Montagu, 1815)

This species was formerly known as *T. tursio*, a name which is now rejected in favour of the designation *T. truncatus*. Scott and Lord (26), though believing that the Southern Tursiops 'closely simulates that of European waters, and upon the whole justifies the retention of a single classification for both parts of the globe', at the same time suggest that the additional distinctive title of 'southern form' should be retained for this dolphin in southern waters. Such a proposal would not be in accordance with the International Rules of Zoological Nomenclature. If the 'southern form' is distinct it should be given definite specific or sub-specific rank. Iredale and Troughton (17), recognizing this, have established a new species, *T. maugeanus*, for Scott and Lord's southern form, but,

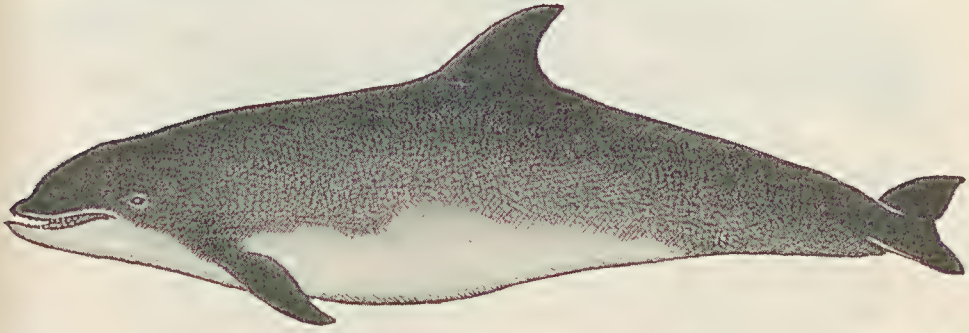

Fig. 12.—The Bottle-nosed Dolphin (*Tursiops truncatus*)

as no diagnosis and no indication as to what characters distinguish it from *T. truncatus* have been published, *maugeanus* is a *nomen nudum*, and cannot stand. Until a complete examination of the 'southern form' has been made it would appear to be advisable to follow Flower (9, p. 481), who stated that the New Zealand form, which, presumably, is identical with the one from Tasmanian waters, differs neither in external appearance nor in its osteological characters from the European form.

Distribution. Universal, ranging from northern temperate to southern temperate seas. Probably not found in polar seas.

External Characters. A large robust dolphin. Maximum length, about 3·0 to 3·3 m. (10-11 ft.), the females being about 10 per cent. shorter than the males. Lower jaw usually projects beyond upper jaw in the males. There is a well-developed, though short, beak. Forehead sloping. About 22-25 large teeth on each side of both jaws. Crown of tooth 17 mm. long, 8 mm. in diameter at the base. One tooth in every 10 mm. of tooth line. Dorsal fin in middle of

back, high and falcate. *Colour*, back and head shining dark-grey or black. Underside white or light-grey, the upper and lower colours passing into each other by insensible gradations.

EXTERNAL MEASUREMENTS of a male, given by Flower (9).

Total length tip of snout to tail notch	2·9 m. (9 ft. 6 in.)
Tip of snout to angle of mouth	10·9 %
Tip of snout to blowhole	13·1 %
Tip of snout to anterior angle of eye	12·9 %
Tip of snout to anterior edge of dorsal fin	44·7 %
Length of flipper	13·6 %
Greatest breadth of flipper	5·3 %
Height of dorsal fin	7·9 %
Breadth of flukes	21·0 %

NATURAL HISTORY. Little appears to be known of the habits of this species. It is stated to ascend estuaries for a considerable distance. The related form *Tursiops catalania*, which is found off the Queensland coast, and may occur in Tasmanian waters, has very interesting habits, which it is stated have been utilized very cunningly by the aborigines. Longman (19, p. 276) has summarized the various accounts of this reputed co-operation. It is stated that the aborigines of Queensland are assisted by this dolphin, which frequents the inshore waters in shoals, in the capture of 'mullet'. The men sit on the sandhills overloking the bay. When a shoal of mullet is sighted the men rush down to the beach and splash the water with their spears. Upon this signal the dolphins drive the mullet inshore. The men enter the water with spears and hand-nets and a scene of confusion follows, in which fish, dolphins, and blacks are all mixed up together. The blacks leave the water when the nets are filled, and the dolphins are left to deal with the remaining fish. It is said that the dolphins will take a fish from the end of a spear when it is offered. The blacks claim that they know the individual dolphins, which become quite tame.

18. THE KILLER

Orcinus orca (Linné, 1758)

I do not propose to follow Iredale and Troughton (16) in assigning to this form the generic name *Grampus*.

DISTRIBUTION. Universal. Probably more common in colder waters.

EXTERNAL CHARACTERS. Grows to a size of 9 m. (30 ft.) in the male and 4·9 m. (16 ft.) in the female. The mature male has the largest dorsal fin of any whale, and may be as much as 1·8 m. (6 ft.) high. The male has relatively larger flippers than the female, and there is a record of a male Killer 9 m. (30 ft.) long, with a flipper 2 m. (6 ft. 8 in.) long and 1·1 m. (3 ft. 7 in.) wide. The flippers are broad and rounded. The teeth are large, and occupy practically the whole length of the gape of the mouth. There are generally 10 to 13 on each side of upper and lower jaws. One tooth in every 35 mm. of tooth line. The *colour* is very characteristic, with sharply

defined black and white (or yellow) areas. The dorsal side is mainly black, but there is a small white patch on each side of the head immediately behind the eyes. There is usually a triangular white patch on each side of the body immediately behind the dorsal fin. The dorsal fin and flippers are black, the flukes black above and white below. The ventral surface has a well-defined white patch, with a wide anterior portion beneath the throat, narrowing behind the flipper, and dividing further back into two lateral areas situated at the sides of the body between the dorsal fin and tail.

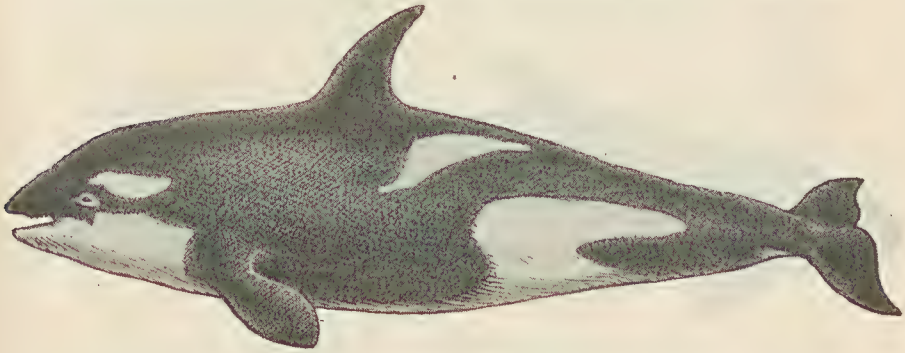

Fig. 13.—The Killer (*Orcinus orca*)

External Measurements of a male, from Eschricht (7).

Total length	6·5 m. (21 ft. 4 in.)
Snout to angle of mouth	7·4 %
Snout to angle of blowhole	12·1 %
Snout to angle of dorsal fin	36·7 %
Snout to angle of base of flipper	16·8 %
Angle of mouth to eye	2·3 %
Length of flipper	18·3 %
Breadth of flipper	15 %
Height of dorsal fin	18·7 %
Length of base of dorsal fin	13·3 %
Distance between flukes	29·3 %

Natural History. The Killer is very powerful and active. It is the most predatory of all whales, and is said to be the only whale which preys upon other whales. A school of Killers will attack a large whalebone whale or sperm whale very much as a pack of hounds will tackle a deer. These predatory habits of the Killer whales were referred to by Pliny. Eschricht (7) reports that the stomach of a Killer contained 13 porpoises and 14 seals.

19. False Killer.

Pseudorca crassidens (Owen, 1846)

Distribution. Cosmopolitan. Probably more abundant in sub-antarctic seas than elsewhere.

External Characters. Maximum length, about 5·8 m. (19 ft.). The males are much larger than the females. The head is obtuse. The flippers are small, narrow, and pointed, and relatively shorter than in the Killer. The dorsal fin is situated slightly in front of the middle of the body and is recurved. The teeth are similar in shape and disposition to those of the Killer. The number varies from 8 to 11 on each side of the upper jaw, and 8 to 12 on each side of the lower jaw. Usually there are more teeth on the lower jaw, and the commonest arrangement is $\frac{8}{10}$. One tooth in every 25 to 30 mm. of tooth line. *Colour*, black all over. Sometimes lighter below.

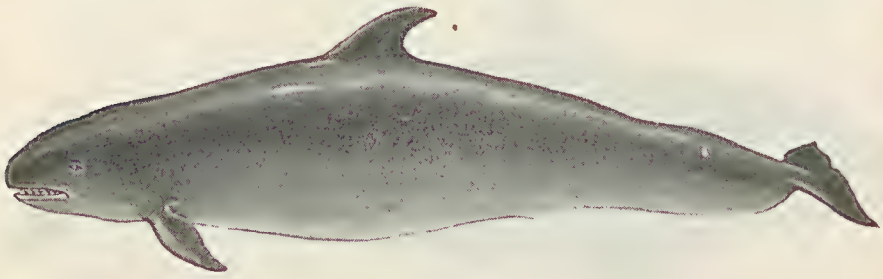

Fig. 14.—The False Killer (*Pseudorca crassidens*)

External Measurements. I can find no records of external measurements. Fortunately, while this paper was in the press a school of False Killers was stranded near Stanley, N.W. Tasmania (June, 1936). Mr. E. O. G. Scott, of Launceston, visited the spot and made numerous observations, including measurements. I am indebted to Mr. Scott for the following measurements of three males, varying from 2·79 m. (9 ft. 2 in.) to 4·65 m. (15 ft. 3 in.), and two females, 2·51 m. (8 ft. 3 in.) and 2·67 m. (8 ft. 9 in.), in length. These measurements show that there is considerable variation in the proportions of the body.

	Males.	Females.
Tip of snout to eye	8·2—11·8 %	9·9—13·1 %
Tip of snout to blowhole	9·6—12·4 %	11·7—12·3 %
Tip of snout to base of flipper	14·5—19·6 %	15·3—21·4 %
Tip of snout to posterior margin of dorsal fin	51·2—62·0 %	63·2—71·7 %
Length of base of dorsal fin	15·2—15·7 %	13·8—14·7 %
Height of dorsal fin	8·3— 8·6 %	7·4— 8·3 %
Length of flipper	11·8—13·2 %	11·5—12·6 %
Greatest breadth of flipper	4·7— 5·0 %	4·6— 5·0 %
Distance between flukes	24·0—24·4 %	20·9—21·4 %

Natural History. This whale was first described by Owen in 1846, from a skull found in a sub-fossil condition in the Lincolnshire fens. Fifteen years later it appeared in the flesh on several occasions in the Baltic, and provided Reinhardt (25) with material for a monograph, in which he assigned the False Killer to a new genus, *Pseudorca*. Most subsequent writers have accepted this generic dis-

tinction, though the points in which the Killer and False Killer differ are not very great, and it is doubtful if there is justification for placing these two forms in separate genera. Since its first discovery this species has been recorded from various parts of the world. It occurs in large schools consisting of several hundreds of individuals, and on many occasions more than one hundred specimens have been stranded. In the southern seas it is probable that, in common with most whales, the False Killer migrates into warm tropical and sub-tropical waters in the breeding season (winter), and returns southward in the summer. It is interesting to note that the first record of this species from the southern hemisphere was based upon the Tasmanian specimens sent to the Royal College of Surgeons in 1864 by Dr. W. L. Crowther, of Hobart Town, and described by him as the Blackfish. It is not unlikely that Tasmanian whalers used this term for two distinct forms, the False Killer and the Pilot whale.

20. Pilot Whale

Globicephalus melas (Traill, 1909)

Iredale and Troughton (16) have given reasons for concluding that Lacépède's *Delphinus ventricosus*, established in 1804, referred to the Pilot Whale. If they are right the specific name *ventricosus*

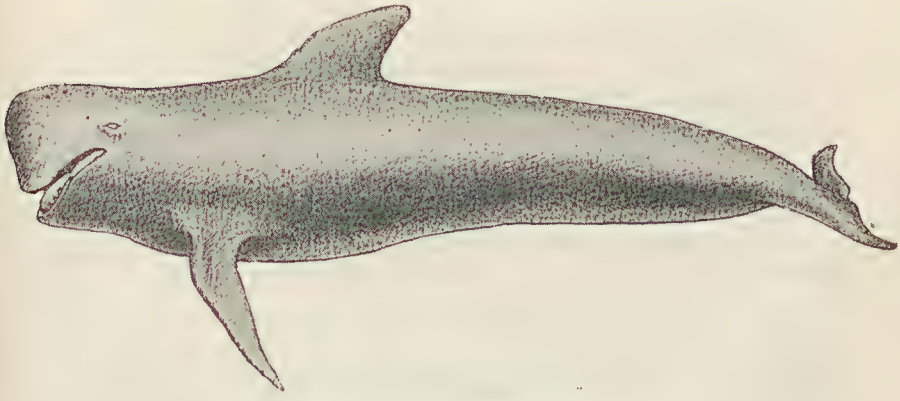

Fig. 15.—The Pilot Whale (*Globicephalus melas*)

would have priority over *melas*. I am not convinced, however, that their case has been established, and I propose, therefore, to retain the name by which this form is generally known.

Distribution. Universal in tropical, temperate, and sub-polar seas.

External Characters. May reach a length of 8·5 m. (28 ft.). It is easily recognized by the shape of its head and the length of the flippers. The head is swollen in front, where it is almost globular.

It overhangs the upper jaw, which forms a very short beak. The flippers are relatively much longer than in any other toothed whale. The dorsal fin is well developed, and is in the anterior half of the body. The number of teeth is very variable. Normally there are about 10 teeth on each side of both jaws, with a maximum of 13 on the upper and 11 on the lower, according to Mr. E. O. G. Scott's observations. One tooth in every 15 to 18 mm. of tooth line. *Colour*, variable, generally described as black all over, with a small amount of white on the under-side. The white (or greyish-white) of the under-surface usually consists of a broad patch under the throat, which sends lateral extensions to the two flippers and a narrow median extension backwards to join a large area which reaches the posterior third of the body.

External Measurements. The following measurements were made from specimens which were stranded at Stanley, North-Western Tasmania, in October, 1935.[1] The measurements are given in percentages of the total length.

	Male.	Female.	Female. Foetus.
Total length to caudal notch	3·87 m.	3·88 m.	1·02 m.
Tip of snout to vent	59·4 %	62·3 %	65·6 %
Tip of snout to base of flipper	16·2 %	16·6 %	20·4 %
Tip of snout to front edge of dorsal fin	20·2 %	30·5 %	39·0 %
Tip of snout to blowhole	10·1 %	9·5 %	10·2 %
Length of mouth cleft (measured along the mouth)	8·0 %	8·6 %	8·1 %
Length of flipper	16·9 %	18·8 %	22·9 %
Breadth of flipper	4·8 %	5·3 %	5·8 %
Height of dorsal fin	5·4 %	6·1 %	6·8 %
Width of flukes	20·4 %	19·5 %	18·5 %

A comparison of the foetal with the adult measurements shows that in the younger stages the anterior half of the body is proportionately larger than in the older stages. This is shown, for example, in the comparisons of the length from the snout to vent and in the length of the flippers.

Natural History. This species travels about in large schools. Beddard (2, p. 281) has given a good account of the method of capturing this species. This whale has been fished for many centuries in the northern hemisphere. When a school is sighted the fishermen put out to sea in numerous boats, with the object of driving the whales ashore. Hence the Scottish vernacular term 'Caa'ing whale', which means 'driving whale'. According to Beddard, an average whale gives 1½ barrels of oil, valued at £3 7s. 6d. The meat is dried and pickled, and the stomach is dried and made into buoys.

A large school of nearly 300 Pilot Whales was stranded near Stanley, North-Western Tasmania, on 14th October, 1935. Mr. E. O. G. Scott, B.Sc., of the Queen Victoria Museum, Launceston, accom-

[1] The measurements of the two adults are taken from very copious notes made by Mr. E. O. G. Scott, to whom I am also indebted for the details of the colour of this species, as well as for other information.

panied by Mr. Cunningham, of the Tasmanian Museum and Art Gallery, Hobart, visited the spot, and I am indebted to Mr. Scott for the information I have given regarding measurements and colours. The sex of 194 individuals was determined by Mr. Scott, 80 being males and 114 females. Detailed measurements of 20 specimens were made by Mr. Scott. The largest specimen measured was about 6·1 m. (20 ft.) long. It is hoped that a detailed account of Mr. Scott's observations will be published in the next issue of this Journal.

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The Royal Society of Tasmania

Annual Report
1935

The Council and Officers

The annual meeting was held at the Society's Rooms, Tasmanian Museum, Hobart, on the 11th March, 1935.

The following were elected as members of the Council for 1935:—Mr. S. Angel, Mr. H. Allport, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. V. V. Hickman, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin, Mr. F. E. Ward.

His Excellency the Governor nominated the following members as Vice-Presidents:—Mr. W. H. Clemes, Mr. F. E. Ward.

The Council at its first meeting made the following appointments:—

Chairman of the Council: Mr. W. H. Clemes.
Secretary: Dr. Joseph Pearson.
Hon. Treasurer: Mr. S. Angel.
Standing Committee: Mr. Unwin, Dr. Lewis, and Dr. Pearson.

Representatives of the Society on the Board of Trustees of the Tasmanian Museum and Botanical Gardens:—Mr. W. H. Clemes, Dr. W. L. Crowther, Dr. A. N. Lewis, Mr. S. Angel, Mr. E. E. Unwin, Hon. L. M. Shoobridge.

Meetings

Nine meetings have been held during the year, and in addition to the lectures delivered, scientific papers of considerable value and interest were submitted for publication.

(See abstract of meetings for abstracts of lectures, papers, &c.)

Library

The Society's library still continues to be of service to members and others desiring scientific and historical information. A number of new volumes has been added to the various sections during

the year. In December, 1934, the number of books totalled 17,969, and in December, 1935, 18,254, showing that 285 volumes have been added during the year.

Mrs. Clive Lord was appointed Assistant-Librarian in November, 1933, and has continued to act since that date. In consequence it has been possible to reorganize the Library and to make a complete rearrangement of the books on the shelves, and the Library has benefited considerably by Mrs. Lord's services.

Owing to congestion in the Library it was found imperative to obtain new book-cases. As no Society funds were available, an appeal was made to members, with the result that £11 11s. 6d. was obtained. In addition one member paid a life membership subscription (£15) in order to assist this project. The Council decided to utilize this life membership fee for this special purpose. Thus the Council was enabled to provide two new book-cases.

Membership

The membership for the year, compared with that of 1934, is as follows:—

	1934.	1935.
Honorary members	4	4
Corresponding members	5	4
Life members	6	7
Ordinary members	245	229
Total	260	244

During the year 38 names were removed from the membership owing to deaths, resignations, &c., and 22 new members were added.

The Council regrets to have to record that the following members have died during the year:—

Mr. J. M. Bowling.
Mr. W. T. Gellibrand.
Mr. W. Graham.
Mr. J. E. C. Knight.
Sir N. E. Lewis, K.C.M.G., M.A., B.C.L., LL.B.
Dr. R. Pulleine.

Papers and Proceedings

The Government has again assisted with the printing of the Papers and Proceedings, and this concession is greatly appreciated by the Council.

Abstract of Proceedings

1935

11th March, 1935

Annual Meeting

The annual meeting was held at the Society's Rooms, Tasmanian Museum, on this date. In the absence of the President, His Excellency Sir Ernest Clark, K.C.B., C.B.E., Mr. W. H. Clemes presided.

The following were elected as members of the Council for 1935:—Mr. H. Allport, Mr. S. Angel, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. V. V. Hickman, Dr. A. N. Lewis, Mr. F. E. Ward.

The President not being present, the appointment of the new Vice-Presidents was deferred until next meeting.

Mr. Walter E. Taylor was appointed Hon. Auditor.

The following members were elected:—Miss E. Atkinson, Mr. J. H. B. Ewart.

Mr. R. W. Legge presented to the Tasmanian Museum, through the Royal Society, the skull of a juvenile Tasmanian aboriginal. Presentation to the Society was also made by Mr. S. K. Johnstone of a list of historical references to ships and seafaring men sailing from Hobart in the old days.

Mr. E. E. Unwin, M.Sc., gave an illustrated lecture on 'The Breathing of Animals', of which the following is an abstract:—

> Oxygen is one of the primal needs of all living organisms. The vast majority obtain this oxygen for the fires of life from the gas in the air or dissolved in the water.
>
> The story of the breathing of animals is the story of adaptation, and is one of the chapters in the story of evolution.
>
> The main story begins with simple forms breathing through the surface in contact with water, and goes on to the acquisition of gills—special thin-walled organs developed in relation to a blood circulation, with oxygen storage media.
>
> The stories of isopods and insects were dealt with more fully, as they show the wonderful adaptability of creatures to a change in their normal environment.
>
> The breathing of the mollusca, fishes, frogs, birds, and mammals was dealt with in brief outline, giving some idea of the gradual change from aquatic to aerial life, and the increasing complexity and more active life demanding more efficient breathing arrangements.
>
> The lecture was illustrated by about 80 slides.

8th April, 1935

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Under Rule 3 His Excellency the President nominated the following two Vice-Presidents:—Mr. W. H. Clemes, Mr. F. E. Ward.

The following members were elected:—Mrs. J. Pearson, Mr. C. E. Radcliff, Mr. J. W. Evans, Mr. John Reynolds, Mr. Wilfred Hudspeth, Mr. F. E. Wallace.

Mr. W. H. Hudspeth delivered an illustrated lecture entitled 'The Experiences of a Settler in the Early Days of Van Diemen's Land.' (See this Volume, p. 139.)

13TH MAY, 1935

A meeting was held in the Society's Rooms, Mr. W. H. Clemes presiding.

The following members were elected:—Mr. E. Parkes, Mr. D. A. McNeice.

Mr. K. M. Dallas, B.Com., gave a lecture entitled 'The Study of Economic Science,' of which the following is an abstract:—

THE STUDY OF ECONOMIC SCIENCE

'Economics is a branch of Biology, broadly interpreted.' (Alfred Marshall.)

Economic Science studies certain *aspects* of human behaviour—more particularly the manner in which Value measures human motives—or 'human behaviour as a relationship between Ends and Scarce Means which have alternative uses.' (Lionel Robbins.)

The current notion that Economics is concerned with a narrow materialism, with Man and his acquisitive instincts, with discovering laws based on self-interest of an Economic Man, is one hundred years behind the present development of the Science. The definition given shows that the science is concerned with certain *aspects* of all social phenomena, not with a separate body of facts. All social sciences study the same facts, but in different aspects or relationships. 'The Economist must also be "philosopher, mathematician, politician, historian"—in some degree.' (J. M. Keynes.)

The central concept of the Science is Value. Two centuries of deductive reasoning, approaching the concept from the angles of Cost of Production and from Utility, and Final or Marginal Utility, have gone to the building of an organon or method of reasoning—not a body of final, concrete truth, but an engine for the discovery of concrete truth. The theory of Value must suffice to explain the human motives behind all such phenomena as prices, wages, interest, rent; behind saving, spending, lending, borrowing. The economist specializes in the study of certain aspects of these phenomena, those aspects dealing with use of Scarce Means to attain Ends which are either social and collective or individual, but is not unaware that these aspects are influenced by motives, religious, political, altruistic—motives which may cause scarce means to be applied in ways which are wasteful and uneconomic from a narrow material point of view.

The 'laws' of Economic Science are statements of 'tendency' expressed in the indicative mood. Their importance is always *relative* to the circumstances of place or time, and to the strength or weakness of other motives, other aspects than those of Value,—of Ends and Scarce Means.

In this broad sense the Generalizations of Economics are valid alike for the solitary Crusoe, the society of private profit and enterprise, the ordered, regimented society of Soviet Russia, and for the never-to-be-realized classless state of Communism, in which the 'State shall wither away,' and want, sin, and suffering shall be no more.

10TH JUNE, 1935

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following member was elected:—Miss C. Jensen.

Mr. E. O. G. Scott delivered an illustrated lecture entitled 'Some Aspects of the Study of Tasmanian Fishes,' of which the following is an abstract:—

In the course of a general review of the subject, the speaker dealt with six aspects, as follow. (*a*) *Definitions.*—General preliminary remarks were based on lantern slides illustrating the various connotations of the word 'fish,' external features, outline of classification, and scope (by families) of the Tasmanian fauna relative to the Australian. (*b*) *History.*—Tribute was paid to the work of the late Clive Errol Lord, whose memory they were met that evening to honour; and the history of ichthyology in Tasmania briefly traced successively through the periods 1642-1803, 1804-1833, 1834-1842, 1832 to the present time. (*c*) *Commercial.*—The backward positions of Australia and of Tasmania relative to other States were made evident by slides showing relative value of Australian production, number of ships, value of production (total, and *per capita*) in States, consumption per head, value of imports and exports. Observations were made on the commercial clupeoid fishes, and the vast possibilities of our pelagic fisheries indicated. (*d*) *Sporting.*—The history of the introduction of Salmonidae to Tasmania was briefly recalled. The urgent need for a proper scientific investigation of our fisheries was emphasized, and some general remarks were made on the individual problems presented by our lakes and rivers, and on such relevant ecological factors as animal communities, ecological gradient and succession, daily and seasonal rhythms, and food-chains. Slides were shown illustrating the correlation of physical and chemical factors of the environment with one another and with fish-food and fish, longitudinal distribution in accordance with physiographical conditions, rapids community, food-cycle in small lake, principal items of trout-food, trout leaping falls, large rainbow trout. (*e*) *Methods of Research.*—Some general observations on the nature, distribution, and special problems of the Galaxiidae, or native trout, were followed by some remarks on the speaker's investigations on the family. Slides shown included methods of trapping, characteristics of Galaxiid genera, diagnostic features of species, local distribution (with incidental notes on chief Tasmanian zoogeographic regions), graphs of scope of Tasmanian Galaxiid fauna, rate of growth, ability to survive out of water, &c. (*f*) *General.*—A series of slides was shown, illustrating some interesting and peculiar fishes, chiefly from Tasmanian waters.

At the conclusion of the meeting His Excellency the Governor unveiled a memorial tablet in the Museum to the memory of the late Clive E. Lord. Dr. Crowther and Dr. Lewis spoke, and expressed their tribute to the memory of Mr. Lord.

8TH JULY, 1935

A meeting was held in the Society's Rooms, Mr. F. E. Ward presiding.

Mr. W. E. Maclean delivered an illustrated lecture entitled 'Hydro-Electric Developments in Tasmania,' of which the following is an abstract:—

The lecturer referred to the demand for electrical power which arose both during and after the Great War. This demand grew at such an amazing rate that the great industrial nations were compelled to take stock of their power resources, particularly as power development was of vital importance to the proper economic development of the world. Electricity has changed the whole economic future of industry because of three important factors:

1. It supplies a motive power cheaper and more elastic than any other type.
2. It is more efficient than steam or gas, and has led to a reduction in fuel consumption per unit of manufacture.
3. It is capable of more diversified use than any other form of power, and can be automatically controlled.

The lecturer then discussed the problem of securing the uniform consumption of power to enable the authorities to sell its energy at a low price.

In 1929 the survey of the potential waterpower available in Australia for hydro-electric services showed that 74 per cent. of this potential waterpower was located in Tasmania. Tasmania had 7000 horsepower per thousand of population; a figure only exceeded by the Belgian Congo and the Belgian Mandated Territory in West Africa, with 8000 horsepower per thousand.

The State has many of the raw materials used in industry, such as copper, lead, zinc, and limestone; and the supply of timber for pulp and paper making is almost unlimited. With the advantage of a cheap electric power supply at hand, no opportunities should be lost of developing these industries.

Since 1914, when the Hydro-Electric Department came into being, several important contracts have been made for bulk supplies of power to important industries. Extensions have been made to country towns and municipalities. The Waddamana plant has ben enlarged from 10,000 to 66,000 horsepower, and the Shannon Station of 12,000 horsepower has been completed. The latest development was that the third unit of the State's hydro-electric system was now being built, and it would add 66,000 to the 78,000 already existing.

The lecturer concluded by showing a series of slides of various sections of the hydro-electric works at the Great Lake, Waddamana, Tarraleah, and elsewhere.

12TH AUGUST, 1935

A meeting was held in the Society's Rooms, Mr. W. H. Clemes presiding.

The following members were elected:—Mr. George Dick, Mr. Gilbert McKinley, Mr. Basil Rait.

Dr. Joseph Pearson delivered an illustrated lecture entitled 'Heredity,' of which the following is an abstract:—

The lecturer summarized our present knowledge of the physical basis of heredity. The elements of germ plasm known as genes are responsible for the characteristics of an organism. Just as the genes are handed on from generation to generation as units which do not lose their identity, so the characters produced by them remain unchanged though they may be suppressed. Thus, maternal and paternal characteristics which are handed on to the child do not become blended. For example, the offspring of a homozygous blue-eyed father and a homozygous brown-eyed mother will be heterozygous brown-eyed, although their cells will also carry the genes for the blue-eyed character. In this case brown is dominant, and blue is hidden or recessive. Each heterozygous brown-eyed offspring will have ripe germ cells of two kinds, one half carrying the genes for blue and one half carrying the genes for brown. This bears out the phenomena described by Mendel. The existence of incomplete dominance is presented by Andalusian fowls, the well-known blue Andalusian being a hybrid produced from a homozygous white and a homozygous black.

With regard to sex, it is found that normally in the female two X-chromosomes are present, whereas in the male there is only one X-chromosome. When the germ cells become mature each egg will be found to contain one X-chromosome, while only one-half of the male germ cells will contain an X-chromosome. Thus, if an egg is fertilized by a sperm containing an X-chromosome, a female is produced, but if by a sperm lacking the X-chromosome a male will be produced. Like the ordinary chromosomes, the X-chromosomes bear genes. These genes will, therefore, follow the sex, and thus we have sex-linked characters, which are of great importance to breeders of domestic animals.

In human beings, colour-blindness is sex-linked. If the mother is colour-blind and the father normal, all the sons will be colour-blind and all the daughters normal. On the other hand, if the father is colour-blind and the mother normal, all the offspring will be normal, though all the daughters will be 'carriers,' and will be capable of handing on the defect in the next generation.

The lecturer concluded by indicating how the discoveries of the physical basis of inheritance might be applied to human genetics and eugenics.

9TH SEPTEMBER, 1935

A meeting was held in the Society's Rooms, Mr. F. E. Ward presiding.

The following members were elected:—Mr. G. S. Carruthers, Mr. E. R. Hudson.

Mr. V. V. Hickman gave an illustrated lecture entitled 'The Cryptozoic Fauna of Mount Wellington,' of which the following is an abstract:—

THE CRYPTOZOIC FAUNA OF MOUNT WELLINGTON

The cryptozoic fauna of Mount Wellington is rich and varied, but apart from the Insecta very few of the animal groups comprising the fauna have received much attention from students.

Sixteen Land-planarians have been recorded from Tasmania, and six of these are known to occur under logs and stones on the mountain. The most common species is *Geoplana tasmaniana*, which was first discovered by Charles Darwin, when he visited Tasmania in H.M.S. *Beagle* during February, 1836. This planarian has the shape of a narrow leaf, about 35 mm. long. Another species often found at the Cascades is *G. typhlops* Dendy, which grows to a length of 220 mm. It is our largest land-planarian, and is quite blind. Its black oval egg-capsules measure 10 x 5 mm., and are made during August and September. Other species found on the mountain are *G. diemenensis* Dendy, *G. mortoni* Dendy, *G. quinquelineata* Fletcher and Hamilton, and *G. nichollsi* Dendy.

Associated with the Geoplanarians is an interesting Land-nemertean, which appears to be a Tasmanian variety of the Victorian *Geonemertes australiensis* Dendy. When disturbed it shoots out a long proboscis, which functions not only as a weapon of defence, but also as an aid to rapid locomotion, for the Nemertean is able to pull itself along by means of the organ.

Terrestrial Mollusca are well represented on Mount Wellington. Five species belong to the genus *Flammulina*, and three to *Endodonta*, whilst single species belonging to the genera *Caryodes*, *Rhytida*, *Delos*, and *Helicarion* have also been recorded from the mountain. The largest species is the Mountain Snail, *Caryodes dufresni* Leach. The Thrush, *Geocichla macrorhyncha* Gould, feeds largely on this snail. The most common snail is the beautiful *Helicarion cuvieri* Ferrussac. It has a yellowish-brown shell, which is glassy and transparent.

Tasmanian Oligochaeta have not received the attention which they deserve, and the mountain offers a fruitful field for research in this group. The Hirudinea are represented by the little land-leech, *Philaemon pungens* Blanchard. It is not a strictly cryptozoic animal. During the winter, however, it hides under logs, and in November and December makes its egg capsules. These are rounded, and have a honeycombed outer surface. The young leeches emerge from the capsules in March and April.

Twelve Centipedes have been recorded from Tasmania. Those which occur under logs and stones on Mount Wellington are usually long, slender species, of a yellow or reddish colour. They are blind forms, belonging to the Geophilomorpha, the most common species being *Pachymeroides alter* Chamberlin and *Pachymerellus zygethus* Chamberlin. The Lithobiomorpha are represented by *Henicops maculatus* Newport. There are ten Diplopods reported as occurring in Tasmania. Three species are frequently met with on the mountain, namely, *Amastigogonus tasmanianus* Brolemann, *Tasmanodesmus hardyi* Chamberlin, and at higher altitudes a member of the genus *Procyliosoma*, which has the habit of rolling itself into a ball like an Isopod.

One of the most abundant members of our cryptozoic fauna is the terrestrial Amphipod, *Talitrus sylvaticus* Haswell, which is found from the foot to the summit of the mountain, and usually occurs in moss or among fallen leaves. The Isopod *Oniscus punctatus* Thomson is also plentiful.

The dominant group of cryptozoic animals is the Arachnida, which includes Spiders, Mites, Harvestmen, Scorpions, Pseudoscorpions, &c. All of these groups are well represented on Mount Wellington, but very few of the animals belonging to them have been studied. The most interesting spider on the mountain is the Cave Spider, *Ectatosticta troglodytes* (Higgins and Petterd). Under stones along the banks of the New Town Creek, where it

flows down the mountain, the little spider *Symphytognatha globosa* Hickman makes its conical egg-sac. The female of this species is unique in lacking the tactile appendages or pedipalps.

The only scorpion known to occur on the mountain or elsewhere in Tasmania is the familiar *Cercophonius squama* (Gervaise).

Twelve Harvestmen or Opiliones have been recorded from this State. Of these, *Peckhamius pectinatus* (Pocock), *Lomanella ranivceps* Pocock, and *Pantopsalis tasmanica* Hogg are frequently found in the gullies of Mount Wellington.

The cryptozoic Insects of the mountain have probably received more attention from students than is the case with other groups. Stag-bettles belonging to the genus *Lissotes* are often found under logs. Carnivorous Carabids are also plentiful, a large shining black species, *Percosoma carenoides* White, occurring at the Cascades. On the summit of the mountain the little black earwig *Euboriella tasmanica* Bormans is not uncommon under stones.

To the biologist one of the most interesting cryptozoic animals on the mountain is *Ooperipatus insignis* Dendy. The animal somewhat resembles a small caterpillar and has fourteen pairs of short legs. It captures its prey by means of an entangling sticky secretion, ejected with considerable force from two apertures, one on each side of its head. This little animal has survived from a remote age, and has retained many primitive features in its anatomy, which help us to bridge over the interval between the Annelids and the Arthropods.

Cryptozoic animals have slowly evolved in harmony with the environment in which they have lived during long periods of time. Man's activity in cutting tracks and roads through their haunts, the bush-fires which accompany man's progress, and the introduction of exotic birds will eventually bring about the extermination of many of these interesting forms of life, and the opportunity of studying them will be gone for ever.

16TH OCTOBER, 1935

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following members were elected:—Mr. J. P. Piggott, Mr. S. H. Wellington, Miss Z. G. Ryan.

Reference was made to the loss the Society had sustained in the death of Sir Elliott Lewis. A wreath had been sent by the Council on behalf of the Society, and also a letter of condolence to Lady Lewis and family. His Excellency asked the meeting to confirm the action of the Council, and the motion was passed in silence, the meeting standing as a mark of respect to Sir Elliott Lewis.

Professor A. L. McAulay and Mr. R. G. Brett delivered an illustrated lecture on 'Problems Regarding Tasmanian Eucalypts,' of which the following is an abstract:—

Some of the difficulties of founding the study of Tasmanian eucalypts on recognized botanical species were discussed, and it was suggested that the best starting-point was a search for jordanons. Some jordanons of *E. Gunnii* and related species were given as examples. The cider gum of the Great Lake plateau was mentioned as one, and it was suggested that the trees labelled *E. Gunnii* in National Park constitute a jordanon of *E. Johnstoni*.

Species were next discussed in which there appears to be a continuous series of types, between extremes which have completely different characters. Work was suggested which should give evidence as to whether this condition was due to hybridisation or to variability in the species. *E. Risdoni*, *E. Tasmanica*, and *E. pauciflora* were cited in illustration.

11TH NOVEMBER, 1935

A meeting was held in the Society's Rooms, Mr. W. H. Clemes presiding.

The following members were elected:—Mr. George Fitzpatrick, Major R. G. Smith, Mr. T. Jacobs.

Upon the motion of Dr. Crowther, supported by Mr. E. A. Unwin, the Society's Medal was awarded to Dr. A. N. Lewis—Mr. W. H. Clemes making the presentation.

Dr. Lewis delivered an illustrated lecture entitled 'Our Pulsating World: The Influence of Earth Movements on Human Development.' (See this Volume, p. 1.)

Northern Branch

Annual Report, 1935

The activities of the Northern Branch during 1935 comprised: Annual meeting, followed by public lecture; four ordinary meetings; seven Council meetings; erection and unveiling of memorial pillar in Royal Park.

All meetings were held at the Public Library, Launceston.

20TH MAY, 1935

Annual Meeting

Mr. W. R. Rolph presided. The following officials were elected for 1935:—

President: Mr. A. L. Meston.

Council: The President, Hon. Tasman Shields, Mr. W. R. Rolph, Mr. R. S. Padman, Mr. F. Heyward, Mr. D. V. Allen, Mr. J. E. Heritage, Mr. F. Smithies, Mr. J. R. Forward, and the Secretary.

Secretary: Mr. E. O. G. Scott.

Hon. Auditor: Mr. R. S. Padman.

The statement of accounts, which disclosed a credit balance of £40, was read and adopted.

Public Lecture

The annual meeting was followed at 8 p.m. by a public lecture, 'Tasmania's Scenic Assets,' by Mr. F. Smithies. In the unavoidable absence of the Hon. the Chief Secretary (Mr. T. D'Alton), the Hon. the Minister for Lands and Works (Major T. H. Davies) presided. There was an attendance of about 350.

24TH JUNE, 1935

The President, Mr. A. L. Meston, presided.

Nominations for membership: Miss Zetta Ryan, B.A.; Mr. G. C. McKinlay.

Illustrated lecture: 'Aboriginal Carvings in Tasmania,' by A. L. Meston, M.A.

Discussion: Messrs. D. V. Allen, C. W. Calver, and E. Scott took part in the discussion following the lecture.

15TH JULY, 1935

The President, Mr. A. L. Meston, presided.

Nomination for membership: Mr. E. R. Hudson, B.Sc., B.Ag.

Illustrated lecture: 'Tasmanian Fishes and Fisheries,' by E. O. G. Scott, B.Sc.

Discussion: Messrs. E. R. Hudson, Littler, and A. E. Evershed took part in the discussion following the lecture.

19TH AUGUST, 1935

The President, Mr. A. L. Meston, presided.

Nomination for membership: Mr. S. Wellington, B.Sc.

Illustrated Lecture: 'The Anti-Transportation Movement in Tasmania,' by A. L. Meston, M.A.

Discussion: Messrs. J. R. Palamountain, J. R. Forward, W. D. Weston, S. Wellington, A. E. Evershed, and E. Scott took part in the discussion following the lecture.

30TH SEPTEMBER, 1935

The President, Mr. A. L. Meston, presided.

Nominations for membership: Major R. E. Smith, Mr. J. Jacobs, B.A.

Papers:

(*a*) 'Extinct Tasmanian Pines: Parts 1 and 2,' by H. H. Scott, F.R.S.A.

(*b*) 'Observations on Visits of the Tasmanian Aborigines to the Hunter Islands,' by A. L. Meston, M.A.

(*c*) 'Observations on Fishes of the Family Galaxiidae: Part 1,' by E. O. G. Scott, B.Sc.

Exhibits: On behalf of Mr. L. C. Willes, the Secretary exhibited a nephrite adze found at East Devonport, and believed to be of New Caledonian origin. A polished stone axe from the collection of the Queen Victoria Museum, found at St. Leonards in 1895, and believed to be of New Zealand origin, was also made available for inspection.

Discussion: Dr. Anderson and Messrs. J. Jacobs, King, Isaacs, and C. W. Calver took part in the discussion following the reading of the papers.

Council Meetings

Meetings of the Council were held on 15th April, 29th May, 26th June, 24th July, 21st August, 11th September, and 31st October.

Memorial Pillar

On 18th September, 1935, at 3.30 p.m., in the presence of a large and representative gathering, there was unveiled a memorial pillar, set up in the Royal Park, Launceston, by the Northern Branch to mark the site of the observatory of the late Mr. A. B. Biggs, where the officially accepted determination of the latitude and longitude of Launceston was made, and to commemorate the astronomical work of Mr. Biggs, a former member of this Society, and a frequent contributor to its 'Papers and Proceedings.'

In the unavoidable absence, through indisposition, of the President of the Society, His Excellency Sir Ernest Clark, K.C.B., C.B.E., the President of the Branch, Mr. A. L. Meston, M.A., performed the unveiling ceremony, supported by His Worship the Mayor of Launceston (Alderman E. E. Von Bibra) and by Col. G. E. Harrap, representing the Historical Society of Tasmania.

Mr. F. Heyward, F.R.A.I.A., and Mr. D. S. Jackson presented the plans and specifications, and the pattern for the inscription-tablet, respectively.

Annual Report of the Education Section of the Royal Society, 1936

Seven meetings were held during the year, from April to October, inclusive. The average attendance was 7·1.

At the annual meeting Mr. H. T. Parker was elected President for the ensuing year.

The papers presented and the discussions arranged during the year were:—

May 27: Mr. H. T. Parker, "The New Spelling Book."

June 24: Mr. F. Watts, "An Experiment in the Education of Gifted Children."

July 22: A Round-Table Discussion was opened by Mr. A. A. Vollprecht on "Scoring the Scholarship Examination."

August 19 and September 23: A Round-Table Discussion was opened by Mr. H. T. Parker on "Broadcasting in the Schools."

October 28: Mr. C. McShane, "An Intelligence Survey in Tasmanian Schools."

PAPERS & PROCEEDINGS

OF

THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1936

NATIONAL MU
OF VICTORIA

EDITED BY

JOSEPH PEARSON, D.Sc. (Manc.), D.Sc. (Liverpool), F.R.S.E., F.L.S.

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Papers and Proceedings, 1936

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I

The Embryology of the Syncarid Crustacean, Anaspides tasmaniae

By

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Ralston Lecturer in Biology, The University of Tasmania

Plates I-XIII

(Read 9th November, 1936)

Introduction

Within recent years our knowledge of crustacean embryology has been augmented by the work of Prof. H. G. Cannon on the Branchiopoda, and that of Dr. S. M. Manton on the Leptostraca and Mysidacea. Nothing, however, has been published on the embryology of the Syncarida.* An examination of the development of *Anaspides tasmaniae* Thomson was therefore undertaken. The investigation was carried out at the University of Tasmania during the years 1932-36. The following pages contain an account of the work accomplished up to the end of that period. It is hoped eventually to supplement this research by a further examination of the post-embryonic development.

I desire to express my thanks to the trustees of the John Ralston Bequest, under whose auspices the investigation was made; to Dr. S. M. Manton for copies of her publications; and to my former teacher, Prof. T. T. Flynn, for helpful advice and kindly interest in my work.

* As mentioned above, no previous work on the embryology of a Syncarid crustacean has been published. However, G. Smith (1909, p. 549) has given a brief description of the egg of *Anaspides tasmaniae*, and has stated that he was 'convinced that no complicated metamorphosis is passed through' during development, but that it was 'possible, however, that the young are hatched out from the egg, not with the complete adult structure.'

Sayce (1907, p. 117) has described an immature form of *Koonunga cursor*, which differs but slightly from the adult, and Chappuis (1927, p. 602) states that there appears to be no metamorphosis in the development of the Bathynellidae.

Method of Obtaining the Eggs

The eggs of *Anaspides* measure about 1·0 mm. in diameter. They are laid singly, attached to pieces of wood or other débris in the streams and tarns where the shrimp occurs. Sediment and algal growths in the water soon cover the eggs, concealing them from view, and making it almost impossible to find them.

In March, 1932, a small laboratory aquarium was built and stocked with specimens of *Anaspides*. Little success, however, attended the experiment. It was soon realized that the conditions prevailing in the mountain streams could not be reproduced satisfactorily in the laboratory. Adult specimens of the shrimp rarely lived longer than six to eight weeks under artificial conditions, and no eggs were found in the aquarium. Half-grown specimens could be kept alive for a much longer period, but they died before reaching maturity.

In November, 1932, it was decided to keep a number of shrimps under more natural conditions in a stream on the slopes of Mount Wellington. For this purpose a tributary of the New Town Creek was selected. This stream flows down the north-eastern slopes of the mountain, and empties into the River Derwent at New Town Bay. The bed of the stream is composed of large basaltic rocks and boulders intermingled with coarse gravel and sand. Apart from algal slime there is very little aquatic vegetation in the creek.

During bright, sunny days the adult shrimps spend most of the time hiding in dark recesses among the rocks where the water is flowing rapidly, and it is in such places that they usually lay their eggs. In order to obtain the eggs two small wooden boxes, each measuring about 25 x 20 x 15 cm., were prepared. Through the ends of each box eight holes (15 mm. in diameter) were bored. These were covered on the inside with wire gauze to allow water to circulate freely through the boxes. Two or three stones, some vegetable débris from the bed of the creek, and some pieces of fibrous bark were placed in each box. Fifteen to twenty adult specimens of *Anaspides* were then introduced and the lid closed. The boxes were next completely submerged in a swiftly flowing part of the stream, a number of heavy stones being placed on top of them to keep them from being washed away.

The two boxes were prepared and stocked with shrimps in the above manner on the 9th November, 1932. The creek was not visited again until the 23rd January, 1933. The boxes had therefore been undisturbed for about ten weeks, but the specimens of *Anaspides* were still alive, and appeared to be quite healthy. The water circulating freely through the boxes had carried sufficient food for the shrimps, which had not only survived the ten weeks' confinement in almost complete darkness, but had also laid a number of eggs. Seven eggs were found in one box and thirty-five in the other. Most of the eggs had been deposited in cracks and crevices in the wood of the boxes,

some were on pieces of bark, but only a single egg was found attached to a stone. It was very difficult to remove the eggs without damaging them, since they adhered firmly to the surface on which they had been laid. The pieces of bark, with eggs attached, were therefore placed in water and taken to the laboratory for examination.

The boxes were restocked with *Anaspides* on the 23rd February, and examined periodically. It soon became evident, however, that two boxes were not sufficient. The necessity of leaving the boxes undisturbed over long periods in order to obtain eggs at advanced stages of development made it imperative to place a larger number of boxes in the stream. This procedure was also hastened by the fact that heavy rain fell on the 4th and 5th October, 1933; the creek was flooded and my two boxes washed away. On 10th October the flood-water had subsided sufficiently to allow a new box to be stocked and placed in the stream. Other boxes were added at intervals, and by 10th January, 1934, eleven boxes had been stocked with shrimps and placed in the stream at slightly different altitudes on the mountain. A record of the date, when each box was stocked with shrimps and when eggs were found in it, was kept.

If small strips of wood about the size of a microscope slide were lightly tacked on to the lid of the box, leaving a space of about 1·2 mm. between the wooden strip and the lid, the shrimps would often lay their eggs in this space. The eggs adhered to the wooden strip, which could then be removed with the eggs attached. Moss, rootlets, bark, and stones were also used as natural substances on which the shrimps might deposit their eggs. Of these materials fibrous bark proved to be the most satisfactory. Eggs were rarely laid on stones. (Fig. 1, Pl. I.)

Laying Period

In order to eliminate as far as possible any effect which long confinement might have on the laying period of *Anaspides*, some of the boxes were stocked with new shrimps each month, and the eggs were searched for shortly after the introduction of the shrimps. A fortnight usually elapsed before the shrimps became accustomed to the box and commenced to lay their eggs. Each month of the year eggs at the two-celled and four-celled stages of development were found in the boxes. Laying is therefore not restricted to any particular season, but goes on throughout the year. It appears, however, to be most active during October and November.

Time and Rate of Development

No difficulty was experienced in the laboratory in hatching embryos, which had been allowed to complete their gastrulation stage before being removed from the creek. Some were kept in running water; others were placed in water in petri dishes, and the water frequently

changed. Except for short intervals, when the eggs were being examined under the binocular microscope, they were kept in the dark. Some eggs were left to develop under natural conditions in the mountain stream, so that their time of development might be compared with that of eggs kept under laboratory conditions.

Owing to several of my boxes being washed away on four different occasions by floods in the creek, I am not able to give an unbroken series of results for any one particular year. However, observations carried out over a period of three years have made it possible to determine with reasonable accuracy both the time and the rate of development of the egg of *Anaspides*.

Some of the eggs found in the boxes on the 23rd January, 1933, had already reached the egg-nauplius stage. They were kept under observation in the laboratory until the 21st July, 1933, when one of the embryos hatched out. Eggs laid during the spring and summer months, October to March, take from eight to nine weeks to reach the egg-nauplius stage. Hence the total time of development in the case of the abovementioned embryo was about 35 weeks. Five eggs laid in one of the boxes on or about 28th November, 1933, were allowed to remain in the creek until 16th April, 1934. They were then removed to the laboratory. The embryos hatched out of three of the eggs during the second week of July, 1934, and out of the other two eggs in the following week, the total time of development being 32 to 33 weeks.

The time taken by the embryo to reach different stages in its development may be determined from the results shown in Table I. The transparent nature of the chorion and larval membranes makes it possible to recognize many of the stages of development without having recourse to dissection.

TABLE I.

Rate of Development of the Embryo of *Anaspides* in Eggs Laid during the Months October to March.

Approx. Date of Laying.	*Date of Examining.*	*Age of Embryo in Days.*	*Stage of Development.*	*Remarks.*
16 Nov., '32	23 Jan., '33	68	Early nauplius	fig. 23, Pl. III
16 Nov., '32	4 Mar., '33	108	Post nauplius	fig. 29, Pl. IV
16 Nov., '32	21 July., '33	247	Hatching	
31 Oct., '33	22 Dec., '33	52	Gastrulation	fig. 20, Pl. III
31 Oct., '33	4 Jan., '34	65	Early nauplius	fig. 23, Pl. III
16 Nov., '33	7 Feb., '34	83	Late nauplius	fig. 28, Pl. IV
21 Nov., '33	16 April, '34	146	Thoracic appendages	
28 Nov., '33	12 July, '34	226	Hatching	
5 Mar., '34	2 May, '34	58	Germinal disc	fig. 21, Pl. III
8 Mar., '34	2 June, '34	86	Late nauplius	fig. 28, Pl. IV
16 Jan., '35	18 Feb., '35	33	Beginning of gastrulation	fig. 17, Pl. III
28 Feb., '35	27 Mar., '35	27	Stage just previous to gastrulation	fig. 16, Pl. II.

Eggs laid during the autumn and winter months, April to September, develop to the gastrulation stage, and then remain dormant until the end of October, when development continues, and the embryos hatch out in the following June. An egg laid in April will therefore take about 60 weeks to hatch. The rate of development of eggs laid in the months April to September is indicated in Table II. The results given in this table and in Table I. are selected from observations made on eighty different eggs during the last three years.

TABLE II.

Rate of Development of the Embryo of *Anaspides* in Eggs Laid during the Months April to September.

Approx. Date of Laying.	*Date of Examining.*	*Age of Embryo in Days.*	*Stage of Development.*	*Remarks.*
1 April, '33	4 April, '33	3	Two cells	fig. 7, Pl. II
1 April, '33	8 April, '33	7	Thirty-two cells	
20 April, '33	17 Oct., '33	180	Gastrulation	fig. 18, Pl. III
31 May, '34	21 July, '34	51	Gastrulation	fig. 18, Pl. III
31 May, '34	8 Dec., '34	191	Post nauplius	fig. 29, Pl. IV
30 June, '34	4 July, '34	4	Eight cells	fig. 11, Pl. II.
11 July, '34	8 Sept., '34	59	Gastrulation	fig. 18, Pl. III
11 July, '34	10 Oct., '34	91	Gastrulation	fig. 18, Pl. III
11 July, '34	20 Nov., '34	132	Late nauplius	fig. 28, Pl. IV
28 Aug., '34	12 Sept., '34	15	About 128 cells	
19 Sept., '34	20 Nov., '34	62	Gastrulation	fig. 18, Pl. III

The Hatching Period

It has already been mentioned that eggs laid in the creek during November, and kept for some time under laboratory conditions, hatched in the following July. In order to determine the limits of the hatching period under natural conditions a large number of shrimps were collected from the creek each month from March, 1934, to February, 1935. The length of each specimen from the anterior end of the rostrum to the posterior end of the telson was measured in millimetres. In the case of the small specimens in which the rostrum had not yet been formed, the length was taken from the front of the head to the end of the telson. The percentage number of shrimps of each size from 3·0 mm. to 20·0 mm., found in the catch for each month, was then determined. The results are shown in Table III.

The absence of small specimens of 3-4 mm. in length from the catches for the months November to May, and the presence of such specimens in the catches for the months June to October, make it quite clear that hatching takes place during the latter period. The results also indicate that most of the eggs hatch at the end of June or the beginning of July.

TABLE III.

Percentage Number of Specimens of *Anaspides* of Different Sizes taken in the New Town Creek each month from March, 1934, to February, 1935.

Length of Shrimps in mm.	Percentage Number Taken on—											
	7th Mar., 1934.	16th Apr., 1934.	24th May, 1934.	16th June, 1934.	21st July, 1934.	21st Aug., 1934.	12th Sept., 1934.	19th Oct., 1934.	20th Nov., 1934.	20th Dec., 1934.	21st Jan., 1935.	18th Feb., 1935.
3·0	....	....	....	3	12	2	1	....	....	....	....	....
4·0	....	....	....	....	40	3	37	15	....	....	....	....
5·0	....	....	....	....	12	17	6	18	8	1	....	....
6·0	....	....	....	....	2	17	7	16	14	1	1	....
7·0	....	....	....	....	....	6	....	7	28	14	1	....
8·0	9	....	....	....	....	....	....	2	8	23	8	1
9·0	31	6	....	2	....	....	1	6	3	24	14	8
10·0	19	6	12	4	6	....	1	2	3	6	18	11
11·0	15	38	4	7	4	6	4	....	....	6	14	18
12·0	16	21	14	15	6	2	1	....	....	2	9	23
13·0	4	4	23	13	....	5	7	....	....	....	3	16
14·0	1	10	6	17	4	20	8	....	....	....	2	5
15·0	....	4	17	9	2	12	5	....	....	....	1	3
16·0	1	2	12	7	....	5	8	3	4	1	....	....
17·0	....	....	2	3	2	2	3	7	11	....	....	....
18·0	1	2	....	3	....	....	....	15	3	1	2	....
19·0	....	....	....	....	2	....	....	6	4	2	2	....
20·0	....	....	....	2	....	....	7	....	2	11	2	....
Others	3	7	10	15	8	3	4	3	12	8	23	15

Technique, Fixation, and Staining

In eggs not covered with débris the chorion is so transparent that the embryo may be observed in the living state and certain phases of its development followed.

The fixation of the egg is most difficult. The chorion is not penetrated by Smith's formol-bichromate fluid, which Prof. Cannon (1921, p. 629) and Dr. Manton (1928, p. 364) used in their researches on crustacean embryology. Gilson's fluid and cold sublimate-acetic also fail to penetrate. Hot sublimate-acetic is far too drastic, and disorganizes the yolk. Bouin's picroformol penetrates the chorion very slowly, and will fix early stages. However, as soon as the vitelline membrane has been formed, Bouin's solution fails to give satisfactory results. The tendency of the chorion to curl inwards when broken, and the semi-fluid nature of the yolk, render removal of the chorion, without injury to the embryo, almost impossible. As development proceeds other membranes or larval integuments are formed, and these add to the difficulty of fixation.

The only fixative found to penetrate the chorion, vitelline membrane, and larval integuments is Carnoy's fluid (Glacial acetic acid 1 part, Absolute alcohol 6 parts, Chloroform 3 parts). This fluid

penetrates with considerable rapidity, and tends to cause invagination of the chorion, accompanied by distortion of the embryo. This may be avoided, however, by making a very small perforation in the chorion. Fixation is complete in from 40 to 50 seconds. The eggs are then transferred to 90 per cent. alcohol for 24 hours. The yolk is thus hardened sufficiently to allow removal of the chorion without injury to the embryo. It is not necessary to remove the vitelline membrane, but the thick chorion is an obstacle to accurate orientation. Moreover, it becomes hard and brittle during the process of infiltration, causing trouble later in section cutting. Its removal may be carried out under a binocular dissecting microscope with the aid of needles.

In the one-celled stage the zygote occupies the whole space enclosed by the chorion, and adheres to the latter on fixation. Sections of this stage, therefore, had to be cut with the chorion *in situ*. Many failures resulted, but several complete series of sections of the one-celled stage were thus obtained. In later stages this difficulty is not encountered, and the chorion may be removed in the manner described above.

To facilitate manipulation and orientation, the eggs were stuck on to small pieces of hardened sheep's brain by the celloidin method. They were then infiltrated with paraffin wax (M.P. 56° C.). Forty minutes in the wax bath gave satisfactory infiltration without rendering the yolk brittle. The wax was changed once before the definitive embedding.

Serial sections were cut at thicknesses of 8-12 μ, and stained with Ehrlich's acid haematoxylin, eosin being sometimes used as a counterstain.

In addition to serial sections, whole mounts of the young germinal disks were made. These were prepared in the following way: After fixation the embryo was stained for about 40 hours in alum-carmine, and then differentiated in acid alcohol for about the same length of time. It was then embedded in paraffin, placed on the microtome, and all the part, other than the germinal disk, cut away. The disk was then removed from the paraffin block by the aid of xylol, and mounted.

General Embryonic Development

The Unsegmented Egg

The newly laid egg of *Anaspides* has a faint purple tinge, and is surrounded by a thick transparent chorion. It is almost spherical in shape, and, including the chorion, measures about one millimetre

in diameter. Ten eggs, when measured under a micrometer eyepiece, gave the following results in millimetres:

(*a*)	1·03 x 1·07
(*b*)	1·01 x 1·05
(*c*)	1·03 x 1·03
(*d*)	1·05 x 1·07
(*e*)	0·98 x 1·04
(*f*)	0·97 x 1·05
(*g*)	0·98 x 1·03
(*h*)	0·96 x 1·08
(*i*)	1·03 x 1·08
(*j*)	0·92 x 1·08

The chorion measures about 14 μ in thickness, and is composed of two layers firmly united. The outer layer is 12 μ in thickness, and in transverse section is seen to be perforated by numerous minute radial tubules. The inner layer measures 2 μ in thickness, and is homogeneous. The outer surface of the chorion is slightly rough, and in the newly-laid egg it is sticky. Sand grains, algal filaments, and other débris in the water of the creek adhere to the egg, and soon hide it from view. The inner surface of the chorion is smooth and has a glazed appearance. When the egg is laid the chorion is quite colourless, but after a few days it takes on a brownish tinge, which is probably due to the absorption of tannins or other pigments derived from fallen leaves and other vegetable matter in the water.

In consistency the chorion resembles a layer of chitin of the same thickness, but it is more readily broken. When fractured it tends to curl inwards and crush the egg. This tendency is retained to some degree even in specimens which have been embedded in paraffin and sectioned.

The newly-laid egg fills the whole space enclosed by the chorion, and at this stage no vitelline membrane is present. The yolk granules are almost spherical in shape, and vary from 5 μ to 19 μ in diameter. The larger granules appear to be more numerous near the surface than near the centre of the egg.

The earliest cytological condition found among the unsegmented eggs examined shows the sperm-nucleus and the egg-nucleus approaching each other. Each nucleus is surrounded by an irregular mass of protoplasm, from which long protoplasmic filaments radiate out amongst the yolk granules. The sperm-nucleus has an irregular ovoid shape, and measures 42 x 48 μ. It is situated about half-way between the centre and outer surface of the egg. The egg-nucleus is also of an irregular ovoid shape, and measures 51 x 57 μ. It is near the centre of the egg.

The next stage shows the two nuclei in contact. The nuclear membranes, however, are still intact, and fusion has not yet taken place. (Figs. 3 and 4, Pl. I.) This stage was met with in a number of eggs,

and it is probable that the two germ-nuclei remain in contact for some time before actual fusion occurs. Eventually, however, the intervening nuclear membranes break down, and the two nuclei coalesce to form a zygote nucleus at the centre of the egg.

While these changes are in progress a marked decrease in the volume of the egg occurs. An egg which, excluding the chorion, measures 1·02 x 1·04 mm. when newly laid, may decrease in size to such a degree, that it measures only 0·65 x 0·71 mm. when the zygote nucleus is formed. As the volume of the egg decreases, the yolk granules, which are somewhat widely separated in the cytoplasm of the newly-laid egg, are brought closer together. The contraction also results in the formation of a wide space between the egg and the chorion.

Segmentation

The egg of *Anaspides* undergoes total segmentation, and, up to the eight-celled stage, the blastomeres are equal in size. The first cleavage furrow is meridional, and divides the egg into two cells, which, at first, are so loosely held together, that they readily fall apart (figs. 5 and 6, Pl. I). However, before the next division, the two cells appear partly to fuse again, and the cleavage furrow becomes shallow (figs. 7 and 8, Pl. II). Serial sections through embryos at the two-celled stage show the nucleus of each blastomere to be near the centre of its cell, and surrounded by an irregular mass of protoplasm, from which strands radiate out among the yolk-granules.

The second cleavage takes place in the usual manner, being meridional and at right angles to the first furrow (figs. 9 and 10, Pl. II). The third cleavage is equatorial, giving rise to eight cells. At first the four blastomeres at one pole are superposed on those at the other pole, but the cells soon move into a position in which the four blastomeres at one pole alternate with those at the other (fig. 11, Pl. II). These eight cells show no tendency to fuse, and after fixation they may be easily separated from one another. Yolk is distributed uniformly through the eight cells.

When segmentation commences, or shortly afterwards, a delicate vitelline membrane is formed around the embryo. At first this membrane is very thin, and fixatives penetrate it, but, when the eight-celled stage has been reached, the membrane is so thick, that it presents a serious obstacle to proper fixation.

The rate of cleavage is slow. An embryo examined at 8.30 p.m. on 4th April was at the two-celled stage. Twenty-four hours later it had reached the four-celled condition, and at 9 p.m. on the 8th April thirty-two blastomeres had been formed.

At the sixteen-celled stage (fig. 12, Pl. II) a small blastocoel has been formed in the centre of the embryo (fig. 13, Pl. II). As segmentation continues the size of the blastocoel becomes larger.

Mesoderm Formation

Segmentation has now become irregular, and appears to be more active at one than at the other pole of the embryo. When moved about, the living embryo usually rotates within the vitelline membrane so that the same pole is always uppermost. It is at this pole that segmentation appears to be more active and the cells smaller than at the other pole. Between the sixteen-celled stage and the thirty-two celled stage a blastomere at the uppermost pole slips into the blastocoel (figs. 13 and 14, Pl. II). As segmentation proceeds, further cells from this pole enter the segmentation cavity, with the result that the surface of the embryo at this pole presents a pitted appearance.

The embryo has now assumed the form of a blastula, the wall of which is composed of a single layer of wedge-shaped blastomeres, surrounding a cavity which is partly filled by an inner mass of cells not arranged in any definite manner (figs. 15 and 16, Pl. II). This inner cell-mass constitutes the primary mesoderm.

The total number of cells entering the blastocoel could not be determined. Serial sections showed that some cells, which had already entered the segmentation cavity, were undergoing mitosis, while others were passing inward.

As development proceeds the nuclei of the outer blastomeres gradually approach the surface. All the cells of the embryo are uniformly rich in yolk.

Gastrulation and Endoderm Formation

When the inward migration of cells into the blastocoel to form the primary mesoderm has ceased, the outer surface of the embryo presents a uniformly segmented appearance. There is very little difference between the blastomeres of the two poles. The pitted appearance of the surface is no longer visible.

The process of gastrulation is initiated by the formation of a crescent-shaped depression occupying a large area at the uppermost pole (figs. 17 and 19, Pl. III). The invagination gradually deepens, its opening becoming smaller and somewhat triangular (fig. 18, Pl. III). This opening is the blastopore. The invagination becomes so deep that it reaches the mass of mesoderm cells in the blastocoel (fig. 20, Pl. III). It constitutes the endodermal rudiment, and later gives rise to the yolk-sac, mid-gut, and liver lobes. The mesoderm cells are pushed to one side of the blastocoel by the invagination and become somewhat flattened. They eventually spread out under the ectoderm and below the future position of the germinal disk.

Invagination goes as far as possible, and at one stage there is a deep archenteric cavity (fig. 20, Pl. III). It is, however, not a permanent cavity, for cells continue to move inward, crowd together,

and obliterate its lumen. The blastopore grows smaller as gastrulation advances, and it finally closes when the cells around its margin come together. However, it never disappears entirely, its position being marked by a small depression in the surface of the embryo. This depression is later replaced by the opening of the proctodaeum.

The endoderm now forms a solid core of cells, which, together with the mesoderm, fills the whole of the blastocoel. All the cells of the embryo are laden with yolk-granules, and, apart from their position, there is little to distinguish the mesoderm cells from those of the endoderm.

In eggs laid in the spring and summer the close of gastrulation is marked by a short period of rest. In autumn and winter eggs it is followed by a long period of dormancy.

Formation of Germinal Disk and Egg-nauplius

After the quiescent period following gastrulation, cell division takes place actively over a wide area immediately in front of the blastopore. This active cell division gives rise to the germinal disk. Its narrow posterior end terminates at the blastopore, whilst its broader anterior end and its sides merge into the region surrounding them. In eggs laid during spring and summer the embryo takes about 60 days to reach the stage of development in which the germinal disk is fully differentiated.

The disk now becomes thickened laterally, while the cells composing its antero-median portion become thin. In this way the typical V-shaped form of the disk, seen in so many crustacean embryos, is attained (fig. 21, Pl. III).

This stage is soon followed by the appearance of the egg-nauplius. The first sign of its development is the formation of the stomodaeum. This appears as a deep crescent-shaped invagination between the arms of the V, and slightly in front of the middle of the disk. The invagination extends backwards below the disk towards the blastopore. At this stage the posterior margin of the stomodaeum is much higher than its anterior margin. The rudiments of the naupliar appendages appear simultaneously as three pairs of thickenings on the lateral arms of the disk. These thickenings soon stand out in high relief above the surface of the disk. The opening of the stomodaeum is now seen to lie between the rudiments of the antennae (fig. 23, Pl. III). Immediately in front of the blastopore is a pair of small lateral thickenings, which later give rise to the caudal papilla. The portion of the disk in front of the stomodaeum and between the antennules soon becomes thickened and elevated to form the labrum.

Up to this stage there has been very little indication of the development of the head-lobes, but now, on each side immediately in front of the bases of the antennules, active cell-proliferation occurs, and the paired rudiments of the head-lobes are established. The labrum

is gradually raised above the surface of the disk, and commences to project over the opening of the stomodaeum. The paired lateral elevations in front of the blastopore come together, forming the lobes of the caudal papilla. The extremities of the antennae and mandibles are now distinctly bilobed (fig. 24, Pl. III).

While these changes have been taking place, a marked contraction in the area of the germinal disk has occurred. When the rudiments of the naupliar appendages first appeared, they were widely removed from the median line, and projected beyond the sides of the embryo. Now they have been drawn towards the median line, and also closer together (fig. 27, Pl. IV).

Ectodermal Teloblasts

Soon after the establishment of the rudiments of the naupliar appendages the ectodermal teloblasts appear. These at first form an irregular transverse row on either side of the mid-ventral line and immediately in front of the blastopore. Each row consists of seven cells (fig. 25, Pl. IV). The inner ends of the two rows are united by a teloblast in the mid-ventral line. As the germinal disc contracts and the bases of the naupliar appendages are brought closer together, the teloblasts tend to form a curved row round the caudal papilla, which has now been formed (fig. 26, Pl. IV). Yolk-granules in the teloblastic cells are rapidly absorbed, and the cell-nuclei become greatly enlarged. This is soon followed by the division of the cells to form the usual tranverse rows of descendants. The teloblasts do not form a complete ring around the caudal papilla until about the fourteenth week. The complete ring consists of nineteen cells, there being one in the mid-ventral line and nine on each side (figs. 53-54, Pl. VIII).

During the development of the egg-nauplius a new investing membrane is formed. This is the *first larval integument* or *embryonic cuticle*. It eventually becomes very thick and elastic, and plays an important part in the process of hatching.

The embryo is now surrounded by three investments, namely, the chorion, the vitelline membrane, and the first larval integument.

Whenever the age of an embryo is mentioned in the following pages, it is to be regarded as having reference to an embryo developed in an egg laid in early summer.

Further Changes in the External Shape of the Embryo

In eggs laid during early summer the embryo takes about eleven weeks to reach the stage of development shown in fig. 27, Pl. IV. In the twelfth week the head-lobes develop rapidly and the labrum increases in length and breadth. Little change occurs in the shape of the antennules, but the bilobed nature of the antennae becomes still more pronounced, the exopodite being distinctly longer than the endopodite. The mandibles lose their bilobed appearance and become

pyriform, the narrow distal portion later giving rise to the mandibular palp. Meanwhile the caudal papilla has increased in size, and the opening of the proctodaeum has become established in the position formerly occupied by the blastopore. The first row of ectodermal teloblasts partly encircling the papilla appears at this stage (fig. 28, Pl. IV).

In fourteen weeks the head lobes are clearly defined, and curve outward in front of the base of the antennules. The central cell of each lobe is still visible. A rudimentary median eye in the form of a small pigment-spot has appeared in the apex of the V-shaped area between the head-lobes (fig. 29, Pl. IV). The tip of the labrum lies between the mandibles. The three basal segments of the antennules are established. In the antennae the two basal segments, coxopodite and basipodite, are first differentiated at this stage, and there is a marked increase in the length of the two rami, but the exopodite is still somewhat longer than the endopodite. The embryo has now become distinctly narrower and more elongate, but is wider anteriorly than posteriorly. Immediately behind and between the mandibles appear the rudiments of the maxillules. These are separated from the caudal papilla by the tranverse caudal furrow. This furrow and the maxillules are soon hidden by the bending forward of the papilla. The end of the papilla is divided into two blunt lobes, which subsequently give rise to the caudal fork. The proctodaeum opens in the notch between the caudal lobes.

The post-mandibular segments of the trunk are formed by growth from teloblasts in front of the blastopore, and arise in succession from before backwards. The limb rudiments also appear in succession from before backwards.

The first larval integument has now become relatively thick. It surrounds the embryo loosely, and is attached only at the ends of the antennules and antennae. A *second larval integument* has been formed, but is not shed until just before hatching.

In about sixteen weeks the central cell of the head-lobes has disappeared. The median eye-spot has become larger and more distinct. The antennules and antennae have commenced to curve upwards and backwards at the sides of the embryo. The two rami of the antennae are segmented, and the endopodite, which at first was shorter than the exopodite, is now equal to it in length. The rudiments of the maxillules are now followed by those of the maxillae and the first three pairs of thoracic appendages. The caudal papilla has curved forward, and the angle of flexure has shifted to the third thoracic segment (fig. 30, Pl. IV).

In eighteen weeks pigmentation of the paired eyes appears. The median eye-spot has become elongated and pear-shaped. The endopodite of the antennules is not yet formed. The antennary endopodite is now distinctly longer than the exopodite, and as development proceeds

the difference in length becomes more pronounced owing to retardation in the growth of the exopodite. The rudiments of the first seven pairs of thoracic appendages have been formed, and the biramous nature of the first six pairs soon becomes apparent. At first there is very little difference in length between endopodite and exopodite. Eventually, however, the growth of the endopodite exceeds that of the exopodite. The embryo has now completed a little more than half the period which it spends in the egg. Flexure of the body and the increase in length of the embryo have brought the caudal extremity into contact with the front of the labrum. The body tapers gradually from the anterior to the posterior end, there being no sudden diminution in size at any point.

From this stage onward the chief changes in form consist in the further development of the appendages. The eighth thoracic limbs soon appear, and are followed in succession by the abdominal limbs. The epipodial gills of the first seven thoracic appendages are developed shortly before hatching. The small leaf-like endopodite, which, in the adult, is present on the first four pairs of abdominal limbs, is not developed until after hatching. As they develop the thoracic limbs are directed downwards, the second, third, and fourth pairs being on the outer side of the others, which, owing to the flexure of the body, lie between them. The five pairs of abdominal appendages and the uropods at first curve upwards at the sides of the abdomen.

At the twenty-second week a large saddle-shaped median dorsal-organ has been formed. Anteriorly it is bounded by a transverse groove immediately behind the paired eyes, whilst its posterior margin is the junction between the first and second thoracic segments. Laterally it extends to the level of the paired eyes. In the living embryo the organ has a yellowish appearance. It seems to reach its maximum development about the twenty-fifth week, and then slowly degenerates, but does not disappear until after hatching. No dorso-lateral organs are present.

During the last few weeks before hatching the embryo becomes deeply pigmented on the front of the head between the eyes, and to a less extent on the back and sides of the trunk segments (fig. 31, Pl. V).

As stated above, the embryo hatches from eggs laid during early summer in from thirty-two to thirty-five weeks.

Post-Embryonic Development

The Process of Hatching

As mentioned previously, five eggs hatched in the laboratory during the second and third weeks of July, 1934. In the case of one of these eggs I was fortunate enough to observe the process of hatching. Shortly before 12 midnight on the 17th July a crack appeared in the chorion, and extended gradually round it in a meridional plane (fig. 32, Pl. V). At 12.10 a.m. on the 18th July the crack had opened

and the vitelline membrane had burst. The first larval integument, however, was still intact, but had commenced to bulge out through the opening in the chorion. It was becoming slowly distended by osmosis. The expanding of this membrane gradually forced apart the two portions of the chorion, thus preventing their curling inwards and crushing the embryo (fig. 33, Pl. V). The shrimp was now enclosed in a perfectly transparent ovoid sac formed by the first larval integument. This sac measured 2·0 x 1·8 mm. It still had the two portions of the chorion and fragments of the ruptured vitelline membrane attached to its outer surface. The increased space within allowed the shrimp to unflex its body, which up to the present had been strongly curved, with the ventral surface of the telson resting against the front of the head (fig. 34, Pl. V). The ovoid sac eventually became quite free from the chorion, and assumed a spherical form. At 1 a.m. it had expanded to a diameter of 2·5 mm.

The shrimp was now moving about actively, and endeavouring to throw off the second larval integument. This had already split on the dorsal side, and was being slowly pushed off the appendages. Ultimately the ecdysis was completed, and the second larval integument lay in a crumpled mass inside the balloon-like first larval integument. At 1.10 a.m. the latter burst, allowing the shrimp to escape.

In another specimen, in which the chorion cracked before 7.30 p.m. on 12th July, the first larval integument did not burst and liberate the shrimp until about 9 p.m. on 13th July.

From the above observations the first larval integument, which is very strong and elastic, seems to serve two important purposes. In the first place, it absorbs water by osmosis, expands, and forces apart the two portions of the fractured chorion. In the second place, it provides a roomy chamber where ecdysis of the second larval integument may take place in safety. (See also fig. 2, Pl. I).

External Characters of the Hatched Embryo

The newly-hatched shrimp (fig. 35, Pl. V) measures 2·70 mm. in length. It differs from the adult mainly in having sessile eyes, no rostrum, a notched telson, and no endopodites on any of the appendages of the first five abdominal segments.

The antennules measure about 1·2 mm. long. The peduncle consists of the three segments present in the adult. The inner flagellum has three, and the outer eleven, segments. Setae are distributed as shown in fig, 36, Pl. VI. The statocyst in the basal joint of the peduncle is well developed, and already contains five clavate rods.

The antennae are slightly shorter than the antennules. The protopodite consists of the usual two segments. The endopodite has nine segments, while the exopodite, which, during embryonic life, was relatively large, has now degenerated to a small scale (fig. 37, Pl. VI).

The head is rounded in front, and has a median longitudinal groove, which extends backward to meet a transverse groove close behind the paired eyes (fig. 40, Pl. VI). This transverse groove grows forward as a V-shaped structure, which subsequently gives rise to the rostrum (fig. 41, Pl. VI), and is therefore called the rostral groove. Immediately behind this groove is a second transverse furrow, which becomes the cervical groove of the adult. The gradual infolding of the ectoderm on each side of the rostral rudiment gives rise to the pedunculated condition later attained by the paired eyes (figs. 42 and 43, Pl. VI). The infolding takes place slowly, and movable articulation of the eyes is not established until eight weeks after hatching. The shrimp is then 4·6 mm. long, and, since escaping from the egg, has undergone at least two ecdyses.

A specimen which hatched in the laboratory on 18th July, 1934, and measured 2·70 mm. long, underwent an ecdysis on the 10th August, 1934, and then measured 3·25 mm. long. Its eyes were still sessile. The specimen was kept alive until 20th August, 1934, when it died, its length being 3·60 mm. All specimens under 4·6 mm. long collected from the mountain streams have sessile eyes.

The rudimentary median eye is still present, situated in front of the head, between and slightly above the basal joints of the antennules. It soon degenerates, and has almost disappeared in specimens 4·0 mm. long.

The four-celled sense-organ on the dorsal surface in front of the cervical groove does not appear until the animal is nearly 5·0 mm. long.

The number of trunk-somites is the same as in the adult, and on the dorsal side there is no indication of the anterior limit of the first thoracic somite. The distance of the cervical groove from the front edge of the second thoracic somite is relatively much greater than in the mature animal. The lateral extensions of the groove run vertically, instead of obliquely, down each side, and end just behind the mandibles. The horizontal groove running backward from the cervical groove on each side is present, but not very pronounced. There is little indication that the sixth abdominal segment is made up of two fused somites.

The telson (fig. 44, Pl. VII) is divided by a deep notch into two lobes, each of which ends in a fringe of six short setae. As the animal grows the notch becomes smaller, and disappears when the shrimp is about 5·3 mm. long.

The mandibles (fig. 39, Pl. VI), maxillules (fig. 47, Pl. VII), and maxillae (fig. 46, Pl. VII) differ very little from those of the adult. The thoracic limbs are also like those of the mature animal (fig. 38, Pl. VI). The first five pairs of abdominal appendages, however, consist only of the protopodite with a six-jointed exopodite (fig. 45,

Pl. VII). The small flabellate endopodite of the first four abdominal limbs does not appear until the animal is 7·0 mm. long. The uropods have the same form as in the adult.

External differences between the sexes do not become apparent until about twenty weeks after hatching. Indications of the development of the copulatory styles in the male are first visible in specimens 10·0 mm. long. In such specimens the endopodites of the first two pairs of abdominal limbs are distinctly elongated and narrow. The serrated spines on the basal part of the inner flagellum of the antennules in the male are not evident until the shrimp is 16·0 mm. long. The first spine to be developed is a long prolateral spine on the sixth segment of the flagellum.

In the female the first external sexual character to appear is the conical papilla situated between the last pair of thoracic limbs. This papilla makes its earliest appearance in specimens about 12 mm. long, but the opening of the spermatheca upon it is not developed until a later stage.

Development of Organs

Further Development of the Mesoderm

When differentiation of the germ-band is completed the mesodermal cells underly it. These cells now constitute the naupliar mesoderm, and are arranged in longitudinal strands below the rudiments of the naupliar appendages (fig. 49, Pl. VII). The posterior ends of the strands lie at the sides of the proctodaeum. A few mesoderm cells are also found in front of the stomodaeum, below the future position of the labrum. At this stage all the cells of the embryo are still laden with yolk-granules. As development proceeds some mesoderm cells and many endoderm cells undergo cytolysis, giving rise to numerous chromatin granules, which become scattered among the yolk-spherules.

Shortly before the appearance of the caudal papilla, the naupliar mesoderm cells at the sides of the proctodaeum grow larger, and their yolk disappears (fig. 50, Pl. VIII). As the stomodaeal invagination is drawn forward (see below) these cells move into position, forming a curved row in front of, and partly surrounding, the proctodaeum. These cells form the mesodermal teloblasts, and give rise to descendants from which the mesodermal somites of the post-mandibular trunk-region are derived (figs. 51 and 52, Pl. VIII).

Much of the naupliar mesoderm retains its yolk until after the embryo has hatched.

The mesodermal teloblasts form an incomplete ring of eight cells (fig. 54, Pl. VIII). Two of the cells are situated one on each side of the mid-ventral line and between the median ectodermal teloblast and the proctodaeum. The remaining six mesodermal teloblasts are situated three on each side of the proctodaeum and towards the

dorsal side. From these six teloblasts the dorsal mesoderm of the trunk somites is formed, while the two ventral teloblasts give rise to the ventral mesoderm (fig. 55, Pl. IX).

The descendants of the mesodermal teloblasts form paired blocks of mesoderm in each trunk segment from the maxillulary segment to the sixth abdominal segment inclusive. As the embryo lengthens, the pressure of the yolk-sac forces the mesodermal blocks to assume a more or less triangular shape in cross-section, and to occupy a position dorso-lateral to the nerve-cord. From its earliest formation each mesodermal somite is divisible into dorsal and ventral portions. The dorsal part of each mesodermal somite grows upward between the yolk-sac and the ectoderm. From this dorsal mesoderm are derived the dorsal vessel, pericardial floor, dorsal longitudinal muscles, and most of the mesodermal investment of the mid-gut.

The ventral part of the mesodermal somites gives rise to the ventral longitudinal muscles and the musculature of the trunk appendages.

The naupliar mesoderm extends beyond the head lobes and in front of the yolk-sac (fig. 64, Pl. XI). Here it constitutes the preantennulary mesoderm. As the embryo lengthens, some of the posterior cells of the naupliar mesoderm spread backwards (or are forced backwards by the elongating yolk-sac), and lie in the trunk segments below and at the sides of the yolk-sac (fig. 65, Pl. XI). In the posterior segments, where the yolk-sac does not press so closely against the dorsal ectoderm, some of these cells lie above it. In this position they become enclosed by the up-growing mesodermal somites, and later are found in both the cardiac and pericardial cavities (fig. 56, Pl. IX). Here and elsewhere many of them lose their yolk granules and become blood corpuscles. However, some of those lying below and at the sides of the yolk-sac become applied to it, and give rise to part of the muscular investment of the mid-gut.

The mesodermal investment of the stomodaeum is derived from the preantennulary mesoderm. Owing to the large quantity of yolk present in the embryonic tissues, I have not been able to recognize with certainty the early formation of a pair of preantennulary mesodermal somites. However, in transverse sections of a newly hatched embryo there is on each side of the stomodaeum a distinct cavity in the mesoderm. This cavity corresponds very closely with the preantennulary coelomic space of *Nebalia* (see Manton, 1934, Fig. 23, f. 1).

As mentioned above, part of the mesodermal investment of the mid-gut is formed from naupliar mesoderm that has spread backwards into the trunk. The larger portion, however, is derived from the dorsal mesoderm of the somites. As the trunk segments are formed, cells from the dorsal mesoderm grow inwards over the dorsal side of the yolk-sac, and then spread downwards to the ventral

side, forming a delicate circular band surrounding the gut. During embryonic life the yolk-sac is of such wide diameter, even in the abdominal region, that complete investment by the mesoderm is not effected until after hatching. Complete investment occurs first at the junction of the mid-gut and proctodaeum, then in the preceding abdominal segments in turn from behind forwards; but even in a newly hatched specimen it is not well defined further forward than the fourth abdominal segment.

Heart and Coelomic Cavities

The development of the dorsal vessel is most clearly observed in the posterior segments, where the yolk-sac does not press so closely against the dorsal ectoderm. As each segment is formed some of the cells in the dorsal part of the mesodermal somites become oriented lengthwise to form the dorsal longitudinal muscles, others creep upward between these muscles and the yolk-sac, finally reaching the dorsal ectoderm (fig. 55, Pl. IX). The mesoderm thus growing upward on either side encloses a space above the yolk-sac. This space becomes the cavity of the dorsal vessel, and the mesodermal upgrowths its lateral walls. Part of the dorsal mesoderm also grows inward over the yolk-sac, the portions from either side meeting near the mid-line to form the floor of the dorsal vessel. In all segments the lateral walls are formed before the floor. As the yolk-sac shrinks in size, the mesoderm between it and the dorsal longitudinal muscles is pulled inward, forming a space on each side between the lateral wall of the dorsal vessel and the ectoderm. This space is the pericardial cavity, and its floor the pericardial floor (fig. 56, Pl. IX). The roof of the dorsal vessel is formed by the upper parts of the lateral walls growing inwards and meeting in the mid-line below the dorsal ectoderm. In all segments the roof is formed after the walls and the floor. In front of the second thoracic segment in a newly hatched embryo the dorsal vessel expands to form a wide cavity, roofed over by the dorsal organ, and extending forward as far as the cervical groove (fig. 57, Pl. IX).

The mesodermal roof of this cavity is not formed until some time after the dorsal organ has disappeared and the shrimp is about 4·0 mm. long.

Coelomic cavities develop early in the ventral part of the pericardial floor (fig. 59, Pl. X). During embryonic life they are compressed in most of the segments by the yolk-sac. They persist, however, until the genital rudiments are formed, and in the newly-hatched embryo they are present in the six abdominal segments, and vestiges of them still appear in the posterior thoracic segments. The coelomic space in the preantennulary mesoderm at the sides of the stomodaeum has already been mentioned.

During the last few weeks of embryonic life the anterior aorta and lateral cephalic arteries develop *in situ* as haemocoelic spaces in the preantennulary mesoderm (fig. 60, Pl. X). The mesoderm, which was originally the anterior part of the naupliar mesoderm, now lies between the yolk-sac and the brain. It is still richly supplied with yolk granules. The haemocoelic spaces extend upwards and backwards, to unite and open into the wide anterior part of the dorsal vessel underlying the dorsal organ.

In the abdominal region behind the first abdominal segment, the wall of the dorsal vessel remains thin and its lumen narrow, but in the thoracic segments the vessel becomes wider and its walls thicker, thus forming the heart (fig. 58, Pl. IX).

The sternal artery, the ventral artery, and the subneural vessel are not formed during embryonic life, and their development after hatching has not been followed.

Alimentary Canal

(*a*) *Fore-gut.* As mentioned above, the crescent-shaped ectodermal invagination giving rise to the stomodaeum is formed shortly after the differentiation of the germinal disk and before the rudiments of the naupliar appendages appear. The posterior margin of the mouth is at first higher than the anterior margin, and the invagination extends backwards in the median line almost to the proctodaeum (fig. 61, Pl. X). As the labrum is formed and begins to project over the mouth, the stomodaeal invagination becomes bent, and its inner end is drawn forward until it lies between the antero-ventral portion of the yolk-sac and the brain (figs. 62-65, Pls. X and XI). Here it soon indents the yolk-sac. The yolk-globules in the ectodermal cells forming the stomodaeal wall are gradually absorbed. By the seventeenth week the cells toward the inner end of the stomodaeum begin to form a thick columnar epithelium, which gradually extends to the outer end. However, where the stomodaeum is in contact with the yolk-sac, the cells do not form a columnar epithelium, but remain thin and flat. The thickening of the wall is accompanied by an increase in the lumen of the stomodaeum at its inner end, to form the cavity of the future cardiac division of the stomach. At the twenty-fifth week the cavity is partly filled by four longitudinal ridge-like thickenings, which project inwards from its wall, one from the dorsal surface, one from the ventral surface, and one from each side. After hatching, and when the shrimp has reached a length of 3·4 mm., the dorsal ridge is differentiated to form the median setose prominence and the two dorso-lateral ridges of the adult. The two lateral ridges in the embryo give rise to the two ventro-lateral ridges in the adult, while the ventral ridge in the embryo forms the median ventral ridge in the mature animal.

(*b*) *Mid-gut.* At the close of gastrulation the blastocoel, as mentioned above, is filled with a mass of endodermal yolk-cells, together with the primary mesoderm (figs. 48 and 49, Pl. VII). The delicate membrane surrounding each yolk-cell is discernible only under the most favourable conditions of fixation. If Carnoy's fluid be allowed to act too long the membrane is destroyed.

With the formation of the germinal disk, many of the yolk-cells on the ventral side of the endodermal mass undergo cytolysis, their nuclei disintegrating into numerous deeply-staining granules, which are scattered among the yolk-globules and finally absorbed (fig. 49, Pl. VII). Cytolysis continues until about the eighteenth week, and then diminishes in activity. During the remaining part of embryonic life, however, isolated yolk-cells may be found in which the nuclei are in process of breaking up.

The outermost cells of the endodermal mass constitute the wall of the yolk-sac, their outer ends forming the yolk-sac membrane (figs. 64-66, Pl. XI). They surround an inner core of yolk-cells, which occupy the space destined to become the lumen of the mid-gut. These inner yolk-cells seem to fuse with each other and sometimes with the inner ends of the outer cells. They are gradually absorbed as development proceeds.

As the embryo lengthens the yolk-sac extends backwards into the caudal papilla (figs. 64-66, Pl. XI). It tapers gradually from the anterior to the posterior end, there being no sudden diminution in diameter marking off a cephalo-thoracic part from an abdominal part. The cells throughout its whole length have the nature of yolk-cells, and not until just before hatching do any of them become converted into epithelial cells. Even the cells opposite the stomodaeum and proctodaeum retain the nature of yolk-cells, and do not form epithelial plates at any stage.

As the yolk in the yolk-cells is absorbed the yolk-sac shrinks in diameter, and its cells become smaller. The conversion of the yolk-cells into the epithelial cells of the mid-gut commences during the last week of embryonic life. It first occurs in the cells forming the dorsal wall of the now elongated yolk-sac, immediately in front of the proctodaeum. It then spreads round to the ventral side, advancing forward at the same time (fig. 66, Pl. XI).

Immediately after hatching, the yolk-cells at the anterior end of the yolk-sac begin to assume an epithelial nature. The indenting of the yolk-sac by the stomodaeum has helped to form a median dorsal pouch overlying the future cardiac division of the stomach. The yolk-cells forming the wall of this pouch are the first anterior cells of the yolk-sac to be converted into epithelial cells. The pouch becomes the anterior diverticulum of the mid-gut.

When the embryo hatches, the lumen of the developing mid-gut behind the fifth thoracic somite is almost empty, but in front it still contains much unabsorbed yolk. This, however, rapidly disappears, and by the time the shrimp is 2·9 mm. long communication of the mid-gut with the stomodaeum and proctodaeum is established. This is brought about by the absorption of the yolk-cells and the breaking down of the thin ectodermal septa at the points of contact.

When *Anaspides* is 3·0 mm. long all the cells forming the wall of the lengthy yolk-sac have become converted into the epithelial cells of the mid-gut. The anterior diverticulum is now well developed, and resembles that of the adult.

The rudiment of the second diverticulum of the mid-gut appears as a dorsal thickening of the gut epithelium in the first abdominal segment when the shrimp is 3·5 mm. long. The diverticulum, however, does not attain its pouch-like form until the animal is about 5·5 mm. long.

The third diverticulum is first apparent as a dorsal thickening of the mid-gut epithelium in the fifth abdominal segment of specimens about 4·0 mm. long. It develops very slowly, and does not become pouch-like until *Anaspides* reaches a length of nearly 14·0 mm.

The endodermal yolk-cells give rise not only to the mid-gut and its three diverticula, but also to the lobes of the liver. The origin of these lobes is described below.

(*c*) *Hind-gut.* A second invagination of the ectoderm to form the hind-gut does not appear to take place. The cells immediately within the lip of the blastopore form the wall of the proctodaeum, and the blastopore becomes the anal aperture. At a later stage this opening is seen to occupy a postero-dorsal position in the notch between the lobes of the caudal papilla. At first the proctodaeum is very short, and the cells forming its wall are rich in yolk-granules. At the seventeenth week the yolk has been absorbed and the cells have become epithelial. The length of the proctodaeum now increases, and its aperture moves from its postero-dorsal position into the postero-ventral position occupied by the anal aperture of the adult. The hind-gut is well developed before hatching, but, as previously mentioned, it does not communicate with the mid-gut until some time after the embryo has escaped from the egg.

The Liver

The liver-lobes are developed from the endodermal yolk-sac. The posterior pair of lobes are the first to be formed. They appear about the nineteenth week as a pair of lateral outgrowths, one on each side of the yolk-sac in the maxillary segment. The outgrowths

soon grow backwards, becoming elongated and finger-like. The wall of each lobe consists of endodermal cells similar to those forming the wall of the yolk-sac. A cap of mesodermal cells covers the end of the lobes (fig. 69, Pl. XII). As the lobes lengthen their cells gradually become epithelial. The conversion takes place first at the posterior end, and then extends towards the front. The lumen of the lobes is filled with yolk-globules, which are slowly absorbed. On hatching, the posterior hepatic lobes have grown backward as far as the second thoracic segment.

Up to the twenty-second week of embryonic life the front of the yolk-sac is rounded. When, however, the dorso-ventral mandibular muscles are formed, they press against the front of the yolk-sac, forming a vertical groove or indentation on each side. The front of the sac is thus divided into a median lobe and two antero-lateral lobes. The median lobe eventually forms the anterior diverticulum of the mid-gut. The two antero-lateral lobes give rise to lobes of the liver. The apex of each antero-lateral lobe of the yolk-sac is attached to the dorsal ectoderm by a short ligament. Immediately behind the point of attachment of the ligament each lobe grows backwards as a finger-like outgrowth to form the anterior hepatic diverticula. These hepatic diverticula are anterior only in the sense that they arise from the antero-lateral lobes of the yolk-sac. They do not project towards the front, but grow towards the posterior end of the body (fig. 70, Pl. XII). They are soon followed by another pair of hepatic lobes, which arise in the same manner immediately behind the point of attachment of the dorsal ligament (fig. 71, Pl. XII). The animal usually hatches with two pairs of liver lobes, but in some cases the rudiments of a third pair are also well established. By the time the shrimp is 7·0 mm. long it has seven pairs of hepatic lobes, and when adult about fifteen pairs.

Genital Rudiment

The genital rudiment appears towards the end of embryonic life. Shortly before the embryo hatches germ-cells, having a large oval nucleus with finely granular chromatin and conspicuous nucleoli, are found on the floor of the coelomic pouches in the first and second thoracic somites. Similar germ-cells appear in succession in the coelomic pouches of the segments behind the second thoracic somite (figs. 72-73, Pl. XII). By the time the embryo hatches these segmental genital rudiments occur in the eight somites of the thorax. Soon after hatching they appear in succession in the six abdominal segments.

As each rudiment is established it grows in length by division of the germ-cells. When the animal is 6·0 mm. long the rudiments in the separate segments have united to form the long gonad of the

adult. Testes and ovary develop in a similar manner. The gonoducts do not appear until much later in the life of the shrimp, and no attempt was made to follow their development.

Whether the genital rudiments in the separate somites are derived from a primary germ-cell, formed in the early stages of the segmentation of the oösperm, could not be determined. They appear, however, to be derived from the mesodermal cells forming the walls of the coelomic pouches.

Nervous System and Sense Organs

Little need be said in regard to the nervous system, which arises in much the same way as in other Crustacea. The development of the protocerebrum, with its central cell surrounded by concentric rows of other cells (fig. 68, Pl. XI), may be compared with the corresponding structure in the egg-nauplius of *Astacus* (Reichenbach, 1886, p. 29).

The median eye at its earliest appearance seems to have a paired origin. It develops from a group of cells lying between the head-lobes (fig. 67, Pl. XI). Two cells in this group, one on each side of the mid-line, give rise to pigment granules. These granules eventually collect round yolk-spheres in the cells. As the yolk is used up the pigment granules form a dense pyriform black mass. The whole structure is very rudimentary, but, like the median eye of some of the lower Decapoda, it persists as a vestigial organ for some time after hatching. In having a paired origin, the median eye of *Anaspides* resembles that of *Artemia* (Moroff, 1912, p. 18). Yolk-granules are found in the plasma of the cells forming the eye in both species. In fact, Moroff (1912, p. 17) states in reference to *Artemia* that 'der ganze Embryo ist von grösseren und kleineren Dotterkugeln erfüllt, die gleichmässig um die Zellkerne verteilt sind.' This condition is not unlike that of the egg-nauplius of *Anaspides*.

The lateral eyes in their development resemble those of *Branchipus* (Claus, 1886, p. 60). During embryonic life, and for several weeks after hatching, they are sessile. The ectoderm gradually grows in under the eyes, both from the front and the back, but it is not until the shrimp is over 4 mm. long that the pedunculated condition is attained (fig. 43, Pl. VI). Hanström (1934, p. 36) has recently shown that the paired eyes resemble those of *Mysis* in their finer structure.

The statocyst in the basal segment of the antennulary peduncle develops as an invagination of the dorsal ectodermal. The club-shaped rods arise from the ectodermal cells forming the outer wall of the invagination. In a newly-hatched embryo five rods are usually present.

The four-celled sense organ, which develops in front of the cervical groove, and which has been compared with a similar organ in the Phyllopoda both by Calman (1896, p. 787) and by Hanström (1934, p. 52), does not appear until *Anaspides* is about 4 mm. long.

In the development of the nerve cord a very distinct ganglion is formed behind that of the sixth abdominal segment. This seventh abdominal ganglion is well defined about the twenty-sixth week of embryonic life (fig. 74, Pl. XIII). As the embryo lengthens the sixth abdominal ganglion is pulled away from the fifth, leaving an intervening space in which yolk-granules collect (fig. 75, Pl. XIII). At the same time the tension on the nerve cord appears to drag the seventh abdominal ganglion into a position partly overlying the sixth. After hatching the intersegmental bar between the sixth and seventh abdominal ganglia becomes very thin (fig. 76, Pl. XIII). It finally breaks down and disappears, and the two ganglia fuse.

Musculature and Endoskeleton

A detailed examination of the development of the musculature and endoskeleton has not been made. The origin and development of the trunk musculature and gut musculature have been briefly mentioned in other parts of this paper. The endoskeleton of *Anaspides*, like that of *Nebalia* (Manton, 1934, p. 202), is formed from intersegmental ectodermal bars which arise from lateral and ventral intuckings. These bars are strongly developed in the mandibular, maxillulary, and maxillary segments. The rudiment of the mandibular bar appears at about the fifteenth week. The other bars are developed in sequence. The greater part of the endoskeleton in the region of the mouth is formed from the first three post-oral bars. These bars are all nucleated, and remain nucleated even in the adult.

A critical study of the endoskeletons of *Anaspides*, *Paranaspides*, *Nebalia*, *Hemimysis*, and *Nyctiphanes* has already been made by Dr. Manton. As a result of this study the close similarity existing between the endophragmal structures of the Syncarida and Leptostraca has been demonstrated (Manton, 1934, p. 220). This similarity is further emphasized by the close agreement in the mode of development.

Maxillary Gland

The rudiment of the maxillary gland appears about the middle of embryonic life. Mesoderm cells begin to form a compact group on each side of the nerve cord in the maxillary somite (fig. 77, Pl. XIII). Yolk granules in the vicinity of these cells are rapidly

absorbed. At first no definite arrangement of the cells can be observed, but as development proceeds the nuclei of the cells become oriented to form more or less regular transverse rows, giving rise to the tubules of the gland (fig. 78, Pl. XIII). The end-sac of the gland soon appears as a large cavity in the group of mesoderm cells. From the gland a duct leads downward in front of the large transverse adductor muscle in the basal segment of the maxilla, curves under the muscle, and eventually opens near the centre of the posterior surface of the appendage (fig. 79, Pl. XIII). Smith (1909, p. 537), in describing the adult animal, states that the duct 'opens by a pore on the external border of the appendage'. This, however, is not the case. Sections through the maxilla of a mature specimen show quite clearly that the duct opens by a pore on the posterior surface. Just before hatching a small invagination of the ectoderm occurs at this spot, and communicates with the duct from the gland. With the exception of this ectodermal lining of the aperture, the whole of the gland and its duct are derived from mesoderm, and are fully developed on hatching (fig. 80, Pl. XIII).

Median Dorsal Organ

The median dorsal organ is not to be confused with the four-celled sense organ, which, in young adults, appears in a median position in front of the cervical groove, and which Calman (1909, p. 164) states 'may be comparable to an obscure "dorsal organ"'. The four-celled sense organ does not develop for some time after hatching, whereas the median dorsal organ appears at about the twenty-first week of embryonic life. It consists of a marked thickening of the dorsal ectoderm, extending from behind the eyes to the front of the second thoracic segment. The ectodermal cells composing it are long and columnar, but become smaller round the margin of the organ. At first the cells contain yolk-globules, and their boundaries are distinct. As development proceeds the cells degenerate, their walls break down, and in some cells the nuclei disintegrate. In the living embryo the organ has a yellowish colour, and is quite conspicuous. It persists for some time after hatching, but has disappeared by the time the animal is 3·5 mm. long.

Habits of Anaspides

The newly-hatched animal moves about actively, sometimes crawling over rocks and débris at the bottom of the water, at other times swimming up to the surface. If it is gently touched when swimming, it will often sink to the bottom, and, lying on its back with its body stretched out in a passive state, remain as if dead for several seconds. This death-feigning habit occurs only in the newly-hatched animal,

and is not exhibited by the adult. Herrick (1895, p. 184) has described a similar peculiarity in young specimens of *Homarus americanus*.

Smith (1909, p. 546) states that *Anaspides* 'will occasionally rise to the surface of the water and turn over on its back in the manner of a Phyllopod'. I am able definitely to confirm the accuracy of this observation. In quiet pools at the side of the mountain stream, where the water is not disturbed by ripples, *Anaspides* often comes to the surface, turns over on its back, and, moving about on the underside of the surface-film, searches for food among the small particles which are floating there. The habit is observed more frequently in young than in adult animals, since the weight of the latter is not so easily supported by the surface tension of the water. Small specimens (5·0 mm. long) not only move about on the under side of the surface-film, but also rest there in an inverted position. I have observed specimens resting in this way for over ten minutes.

The animal does not commence feeding until communication between fore-gut, mid-gut, and hind-gut is established. This occurs a few days after hatching. When the young shrimp begins feeding a long cylindrical tube, about equal in length to the mid-gut, is extruded from the anal aperture, and is carried about for some time before being expelled. This tube is probably composed of the inner ends of the yolk-cells forming the wall of the mid-gut, and is cast off when these cells become epithelial. It is certainly not the ectodermal lining of the hind-gut, which is comparatively short, and is cast off during ecdysis.

Mating has not been observed. However, male specimens in the creek are sometimes seen employing the armed basal joint of the inner antennulary flagellum in an attempt to seize hold of the base of one of the antennules in a female.

Discussion

Segmentation of the Egg

The egg of *Anaspides*, like that of *Lucifer* (Brooks, 1882, p. 64), exhibits complete and equal cleavage. In both a large segmentation cavity is formed, and into this cavity, shortly after the sixteen-celled stage has been reached, a blastomere moves. In *Lucifer* this blastomere divides as it passes inwards. In *Anaspides* it divides after it has entered, and at the same time other blastomeres appear to pass inwards. There is then formed in each case a deep invagination-gastrula with a primitive archenteric cavity. At first all the cells are equally provided with yolk, but at the commencement of invagination in *Lucifer* the yolk has largely disappeared from all

cells except those in the segmentation cavity. The cells of *Anaspides* are laden with yolk granules up to a late stage in development.

Brooks (1880, p. 563) originally regarded the cells lying in the segmentation cavity of *Lucifer* as mesoderm cells. In a later publication (Brooks, 1882, p. 70) he abandoned this opinion in favour of the view that they were yolk pyramids, because they were charged with yolk granules. Unfortunately the subsequent history of these cells was not followed. The corresponding cells in *Anaspides* constitute the primary mesoderm.

Ectodermal and Mesodermal Teloblasts

The trunk region of *Anaspides*, like that of the Leptostraca Peracarida, and Decapoda, is formed from rows of ectodermal and mesodermal teloblasts developed immediately in front of the blastopore. The teloblastic regions of *Hemimysis* and *Nebalia* have been described in detail by Dr. Manton (1928, p. 370; and 1934, p. 178). *Anaspides* agrees with both these forms in possessing an ectodermal teloblast in the mid-ventral line. It has been suggested by Dr. Manton (1934, p. 212) that 'possibly the Decapoda differ from the Peracarida in possessing no mid-ventral ectodermal teloblast'. Sollaud (1923, p. 93) gives a figure of the teloblastic region of *Leander* in which a mid-ventral teloblast is clearly indicated. It is highly probable that a mid-ventral teloblast will be found in all those Crustacea in which teloblastic development of the trunk occurs.

In *Anaspides*, *Nebalia*, and the *Decapoda* the ectodermal teloblasts form a complete ring around the caudal papilla. In both *Anaspides* and *Nebalia* the ring consists of 19 teloblasts.

Four pairs of mesodermal teloblasts are present in *Anaspides*, *Nebalia*, and *Hemimysis*. Patten (1890, p. 371) records a similar number in *Cymothoa*.

External Form

In the development of the external form of the body, and in the order in which the appendages appear, *Anaspides* resembles the Leptostraca and Mysidacea. Owing, however, to the much later rupture of the egg-envelopes, the ventral flexure of the body, like that in the Decapoda, is retained until the embryo is hatched. The strong development of both rami of the second antenna during early embryonic life, followed by the gradual degeneration of the exopodite, recalls the similar changes through which this appendage passes in the larval life of certain Decapoda. Thus in the protozooea of *Penaeus* the second antenna has a three-jointed endopodite and a four-jointed exopodite, but by the time the mysis stage is reached, the exopodite has degenerated into a scale (Müller, 1863, p. 8; and Claus, 1876, p. 11).

In the newly-hatched *Anaspides* the notched telson, with its six pairs of setae, bears some resemblance to that of a protozooea, and perhaps indicates that the ancestors of *Anaspides* passed through some such larval stage.

The Heart and Coelomic Sacs

In its main features the development of the heart resembles that of *Hemimysis* and *Nebalia*. In *Nebalia*, however, the ventral wall of the dorsal vessel appears first, and later the sides and roof, whereas in *Hemimysis* and *Anaspides* the lateral walls are first formed, and then the floor, followed by the roof. As in *Hemimysis*, the pericardial floor is formed from the dorsal mesoderm as it grows upward, and not, as in *Estheria*, by a later downward growth of the dorsal mesoderm.

Coelomic sacs have been demonstrated in *Estheria* (Cannon, 1924, p. 425), *Chirocephalus* (Cannon, 1926, p. 402), *Hemimysis* (Manton, 1928, p. 397), and *Nebalia* (Manton, 1934, p. 227). In *Anaspides*, as in *Hemimysis* and *Chirocephalus*, the coelomic sacs are early compressed between the yolk-sac and developing pericardium, but while in *Chirocephalus* they are soon obliterated, in *Anaspides* and *Hemimysis* they persist throughout embryonic life. In *Anaspides* they are large, and most clearly seen in the newly-hatched embryo, when the yolk-sac is somewhat shrunken, and the trunk, released from its flexed condition, has straightened out. The large size of these coelomic sacs is a primitive character comparable to that in *Estheria* (Cannon, 1924, p. 395).

Alimentary Canal

The position of the anus relative to the blastopore has been reported differently by different authors (see Korschelt and Heider, 1899, p. 173). As pointed out by Dr. Manton (1928, p. 431), it is not always possible to determine with accuracy the relative positions of these two structures, 'since the blastopore may be a vague area and is obliterated before the anus appears'. In *Anaspides*, however, the blastopore is a very definite aperture leading into an archenteric cavity. Although the lumen of this cavity is eventually rendered imperceptible by the crowding together of the endoderm cells, the blastopore is always well defined. It becomes the anal aperture, and the cells immediately within its lip give rise to the proctodaeum.

A critical account of the development of the mid-gut in Crustacea has recently been given (see Manton, 1928, pp. 433-436). A repetition of this account is not needed, but it may be said that generally in the centrolecithal eggs of Crustacea certain cells pass inward from the blastoporal area, absorb yolk, and form yolk-cells, which give rise partly or entirely to the mid-gut. In *Hemimysis* these yolk-cells

spread around the yolk, and form the yolk-sac. Later they are transformed into the epithelial cells of the mid-gut. In *Nebalia* the yolk-sac is at first composed of yolk-cells connected posteriorly with an epithelial endodermal plate. By proliferation of its own cells and transformation of the yolk-cells along its margin, this plate gradually extends forward until all the yolk is enclosed in an epithelial yolk-sac. A similar process probably takes place in *Leander* (see Sollaud, 1923, p. 162). In *Anaspides*, as in *Cetochilus* (Grobben, 1881, p. 243), the cells forming the archenteric invagination are heavily laden with yolk, and are virtually yolk-cells. They give rise directly to the yolk-sac, and later to the mid-gut. In *Cetochilus*, however, the lumen of the invagination persists, whereas in *Anaspides* it is obliterated by some of the yolk-cells crowding into its centre and forming a central core. This condition, although originating in a different way, is similar to that appearing in *Hemimysis* after the yolk-cells have formed the secondary yolk-pyramids. The outer cells of the endodermal mass in *Anaspides* form the yolk-sac, and correspond to the secondary yolk-pyramids of *Hemimysis*, while the inner core of cells in *Anaspides* corresponds to the central core of yolk in *Hemimysis*. In both, the cells forming the yolk-sac become transformed into the epithelium of the mid-gut, the transformation taking place first opposite the stomodaeum and proctodaeum, but somewhat earlier in *Hemimysis* than in *Anaspides*.

Cytolysis occurs only to a small extent in the yolk-cells of *Hemimysis*, but largely in those of *Anaspides*. Degeneration of the yolk-cells occurs extensively in many Decapoda, and has been recorded in *Alpheus* (see Brooks and Herrick, 1892, p. 425), *Homarus* (see Herrick, 1895, p. 211), and *Leander* (see Sollaud, 1923, p. 83).

The Liver

The liver, or hepatopancreas, of the Crustacea does not always develop in the same way. In *Hemimysis* the posterior liver-lobes 'arise independently of the yolk-sac from a pair of epithelial plates of mesoderm which grow round the yolk-sac' (see Manton, 1928, p. 433). In *Anaspides* these lobes are formed as out-pushings of the yolk-sac, which open latero-ventrally into the mid-gut immediately behind the stomodaeum. Sollaud (1923, p. 171) has described a somewhat similar origin for the liver-lobes of *Leander*. The hepatic diverticula of *Nebalia* also develop as outgrowths of the endodermal yolk-sac (see Manton, 1934, p. 183).

The anterior hepatic lobes of *Anaspides* arise in much the same way as those of *Nebalia*, except that the yolk-sac is indented not by a single median depression but by two vertical furrows, one on each side of the anterior mid-gut diverticulum. Moreover, the anterior lobes do not extend forward into the head, but curve over and grow

towards the tail, the primary pair of lobes being soon followed by a second pair, which develop at the point where the first pair bend over.

Maxillary Gland

The maxillary gland of *Anaspides*, like that of *Estheria* (Cannon, 1924, p. 424) and *Chirocephalus* (Cannon, 1926, p. 406), is of mesodermal origin. As in *Chirocephalus*, the end-sac and primordia of the coils appear early. The close similarity in the adult pattern of the maxillary glands of *Chirocephalus* and *Anaspides* has already been demonstrated (see Cannon and Manton, 1927, p. 445). It is not surprising, therefore, to find a similarity in their mode of development.

Genital Rudiment

In *Anaspides*, as in *Nebalia*, the gonads arise in the walls of the coelomic pouches at a late stage in embryonic life. Dr. Manton has already pointed out that, in this respect, *Nebalia* resembles the Annelids, *Peripatus* (Sedgwick, 1887, p. 467) and *Scolopendra* (Heymons, 1901, p. 1). A similar origin of the gonads is also found in spiders, *Limulus*, and other Arthropoda.

Hatching Process and Habits

There is a remarkable similarity in the hatching of *Anaspides* and that of certain Cladocera. The winter-egg of *Daphnia* has no chorion, but is surrounded by a primary yolk membrane or 'Dotterhaut', which corresponds to the vitelline membrane in the egg of *Anaspides*. Below this membrane, during the development of both *Daphnia* and *Anaspides*, two larval integuments are formed. The first appears at the egg-nauplius stage. It becomes strong, elastic, and semipermeable. The second appears somewhat later, and is consequently within the first. Now Volmer (1912, p. 646) has shown that the first larval integument is of the greatest importance in the hatching of *Daphnia*. By osmosis it absorbs water, and swells out like a balloon, bursting first the 'Dotterhaut,' and then the ephippium. In *Anaspides* it behaves in a similar manner, bursting first the vitelline membrane, then the chorion. In each case a long time elapses before the balloon-like structure breaks, liberating the embryo. During this time *Anaspides* throws off the second larval integument.

According to the observations of Spangenberg, quoted by Oehmichen (1921, p. 242), it appears that the larva of *Branchipus* is also surrounded by an expanded transparent investment during hatching.

Anaspides not only resembles the Cladocera in its method of hatching, but also in its habit, when young, of moving about in an inverted position on the under-side of the surface film in calm water. Wagler (1927, p. 353) gives a figure of *Scapholebris* in such a position.

The eggs of *Anaspides* laid during winter resemble the winter-eggs of the Cladocera in going through the early stages of segmentation soon after laying, and then entering upon a long period of dormancy.

Conclusions

From the above discussion it is clear that *Anaspides* shows in its development a close resemblance to the Leptostraca as exemplified by *Nebalia*, the main points of agreement being the following:

(1) The origin and number of ectodermal teloblasts.
(2) Presence of a mid-ventral ectodermal teloblast.
(3) Formation of a complete ring of nineteen ectodermal teloblasts around the caudal papilla.
(4) Presence of four pairs of mesodermal teloblasts.
(5) Irregular nature of the naupliar mesoderm.
(6) Development of the post-mandibular segments from before backwards.
(7) Origin of the liver lobes from the endodermal yolk-sac.
(8) Essential features of the development of the dorsal vessel.
(9) The late appearance of the genital rudiments in the coelomic pouches.
(10) Presence of a similar type of median dorsal organ, which eventually degenerates.
(11) Absence of a free-swimming larval stage.

In points (1), (2), (4), (5), (6), (8), (10), and (11), *Anaspides* and *Nebalia* both resemble the Peracarida.

Although in *Anaspides* the stages of development following differentiation of the germinal disk are mainly Malacostracan in character, the early stages, as in the case of *Lucifer*, bear some resemblance to those of certain Entomostraca. Thus the holoblastic segmentation, followed by the formation of a relatively large blastocoel, recalls the similar stages in the Copepod *Cetochilus*, and also in the Branchiopods *Branchipus* and *Bythotrephes*. The development of an invagination-gastrula, giving rise directly to the mid-gut, is a very primitive condition also seen in *Cetochilus*.

Anaspides also resembles the Branchiopoda in the following respects:

(1) Origin and development of the maxillary gland.
(2) Long persistence of yolk granules in the embryonic tissues.
(3) The prolonged dormancy of the embryo in winter eggs.
(4) The mode of hatching.
(5) The habit of moving about in an inverted position on the under-side of the surface-film in calm water.

Summary

1. *Anaspides tasmaniae* Thomson lays its eggs singly on moss, bark, and other forest débris in the mountain tarns and streams of Tasmania.

2. Egg-laying goes on throughout the year, but is most active during October and November.

3. Eggs laid in the spring and summer hatch in about 32 to 35 weeks. Those laid in autumn and winter undergo the early stages of segmentation, and then become dormant until spring.

4. Hatching takes place in the winter months, June to October.

5. Segmentation is holoblastic, and a large blastocoel is developed.

6. The primary mesoderm is formed by migration of blastomeres into the blastocoel.

7. The formation of the primary mesoderm is followed by the development of a deep invagination-gastrula with a temporary archenteric cavity.

8. The invagination-gastrula gives rise directly to the endodermal yolk-sac, and later the mid-gut. Most of the endoderm cells do not become epithelial in nature until after hatching.

9. Marked cytolysis occurs in the endodermal cells, and also to some extent in the primary mesoderm.

10. A typical V-shaped germinal disk is formed, and gives rise to an egg-nauplius of the usual type. All the cells of the embryo at this stage are laden with yolk granules.

11. The caudal papilla is surrounded by a ring of nineteen ectodermal teloblasts, which give rise to all the post-mandibular segments of the trunk.

12. A mid-ventral ectodermal teloblast is present.

13. The naupliar mesoderm and four pairs of mesodermal teloblasts are derived from the primary mesoderm.

14. The mesodermal teloblasts form paired mesodermal somites, which give rise to the dorsal vessel, the pericardium, the longitudinal muscles of the trunk, the muscles of the post-mandibular appendages, and part of the gut musculature.

15. Coelomic cavities appear in the pericardial floor, and persist until after hatching.

16. The genital rudiments develop in the walls of the coelomic cavities towards the end of embryonic life.

17. The maxillary gland is of mesodermal origin, and appears at an early stage.

18. The liver lobes are formed as outpushings of the endodermal yolk-sac.

19. The presence of a rudimentary seventh abdominal segment, which becomes fused with the sixth, is indicated by the number of ganglia in the embryonic nerve cord.

20. A median dorsal organ is present, and persists for some time after hatching.

21. Yolk granules are found in the tissues of the embryo until a late stage of development.

22. The process of hatching resembles that of the Cladocera.

23. The newly-hatched *Anaspides* differs from the adult in having a rudimentary median eye, sessile paired eyes, no rostrum, a forked telson, no endopodites on any of the appendages of the first five abdominal segments, and no external sex organs.

24. The habits of the young *Anaspides* resemble those of certain Cladocera.

25. A comparison of the development of the Syncarid with that of the Leptostraca, Peracarida, Branchiopoda, and Copepoda is made.

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Plate I

Fig. 1.—Eggs of *Anaspides tasmaniae* Thomson attached to a piece of bark from one of the boxes placed in the creek. × 10.

Fig. 2.—*Anaspides* surrounded by the distended first larval integument during the process of hatching. The broken chorion is seen at the left of the figure. The second larval integument is not yet cast off. × 10.

Fig. 3.—Male and female pronuclei in contact near the centre of the unsegmented egg. × 400.

Fig. 4.—Male and female pronuclei becoming rounded off preparatory to fusion. × 300.

Fig. 5.—Two-celled stage surrounded by the transparent chorion. × 40.

Fig. 6.—Two-celled stage surrounded by the chorion. The blastomeres almost separated by the first cleavage. × 40.

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PLATE II

Fig. 7.—Two-celled stage in which the two blastomeres have partially refused.

Fig. 8.—Section through the stage shown in fig. 7.

Fig. 9.—Four-celled stage.

Fig. 10.—Equatorial section through the four-celled stage.

Fig. 11.—Eight-celled stage.

Fig. 12.—Sixteen-celled stage.

Fig. 13.—Section through an embryo immediately after the sixteen-celled stage, showing a blastomere entering the blastocoel.

Fig. 14.—Section through a slightly later stage than that shown in fig. 13. The blastomere is now in the blastocoel, and is undergoing mitosis to form the primary mesoderm.

Fig. 15.—Section through a stage more advanced than that shown in fig. 14. The blastocoel is much larger, and now contains a number of primary mesoderm cells.

Fig. 16.—Section through a stage just prior to gastrulation.

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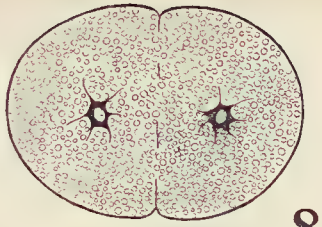

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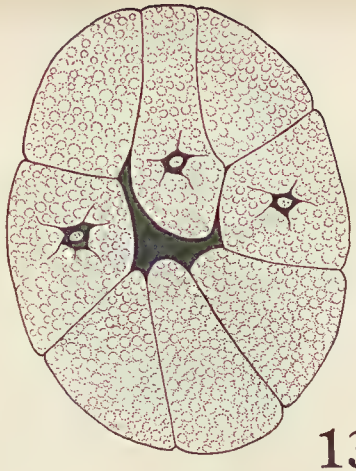

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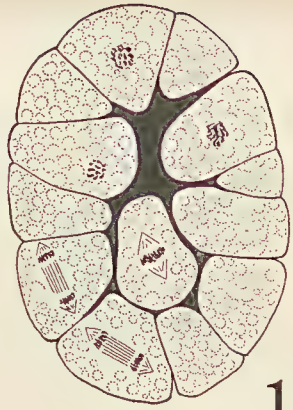

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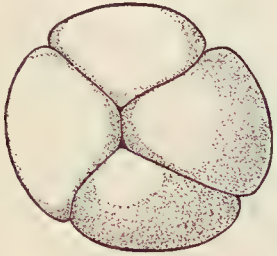

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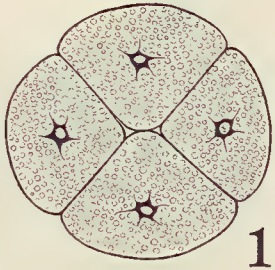

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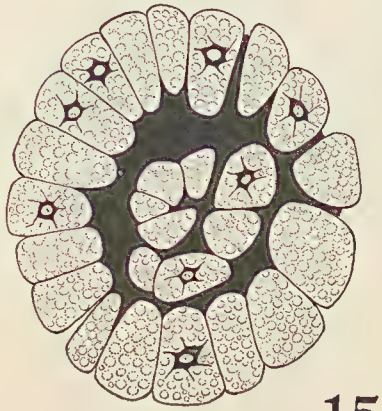

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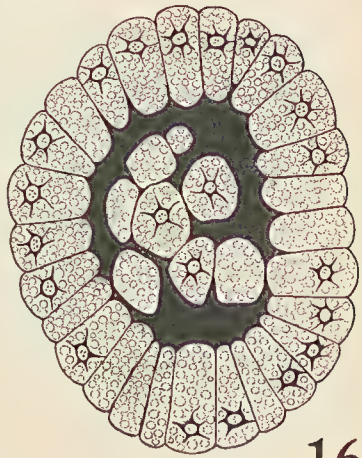

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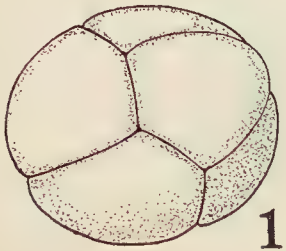

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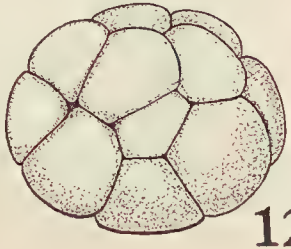

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Plate III

Fig. 17.—Surface view of embryo shortly after the commencement of invagination.

Fig. 18.—Surface view of embryo towards the close of invagination.

Fig. 19.—Sagittal section through embryo at the commencement of invagination.

Fig. 20.—Sagittal section through an embryo during invagination, showing the formation of a temporary archenteric cavity.

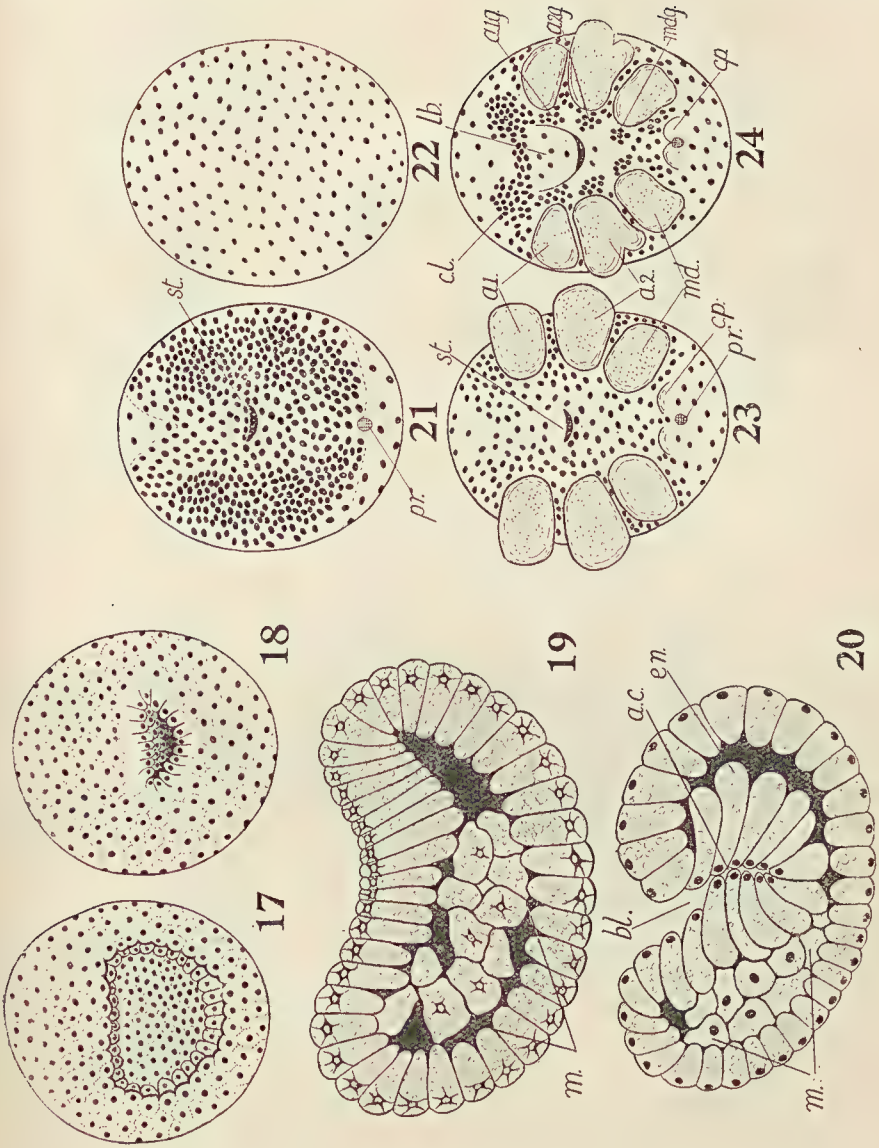
Fig. 21.—Ventral view of an embryo stained with alum-carmine to show the V-shaped germinal disk.

Fig. 22.—Dorsal view of embryo at the same stage as that shown in fig. 21.

Fig. 23.—Ventral view of egg-nauplius at about the ninth week of summer-development. Drawn from a whole mount stained with alum-carmine.

Fig. 24.—Ventral view of egg-nauplius at about the tenth week, showing partial contraction of the disk and the formation of labrum and head-lobes.

a.1., antennule
a.1.g., antennulary ganglion
a.2., antenna
a.2.g., antennary ganglion
a.c., archenteric cavity
bl., blastopore
c.l., cephalic lobe or optic lobe
c.p., caudal papilla
en., endodermal cell
lb., labrum
m., primary mesoderm
md., mandible
md.g., mandibular ganglion
pr., proctodaeum
st., stomodaeum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st.
pr.
lb.
a1.
a2.
c.l.
a1g.
a2g.
mdg.
cp.
md.
a.c.
en.
bl.
m.

Plate IV

Fig. 25.—Surface view of region in the vicinity of the blastopore at the first appearance of the ectodermal teloblasts. Drawn with the aid of a camera lucida from a whole mount stained with alum-carmine.

Fig. 26.—Surface view of blastoporal region when, by the contraction of the disk, the naupliar appendages have come closer together and the row of ectodermal teloblasts has commenced to curve round the caudal papilla. (See also fig. 28.)

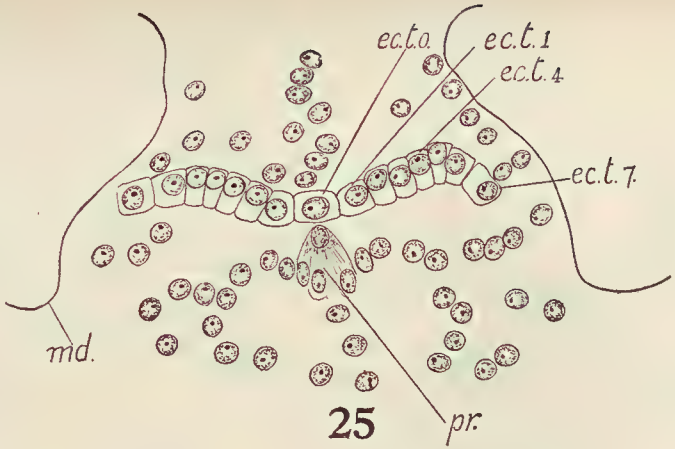
Fig. 27.—Ventral view of egg-nauplius at the eleventh week. The disk has now contracted to such an extent that the appendages no longer project beyond the sides of the embryo. The cells of the head-lobes now form concentric circles.

Fig. 28.—Ventral view of embryo at the thirteenth week. The caudal papilla is now well formed.

Fig. 29.—Ventral view of embryo at the fifteenth week. Median eye and the rudiments of the maxillules have now appeared.

Fig. 30.—Ventral view of embryo at the sixteenth week. Endopodite and exopodite of the antennae are now segmented and about equal in length.

a.1., antennule
a.2., antenna
c.c., central cell of head-lobe
c.l., head-lobe
c.p., caudal papilla
ec.t., ectodermal teloblast
ec.t.0., median ectodermal teleblast
ec.t.1.,-*ec.t*.7., lateral ectodermal teloblasts
lb., labrum
m.d., mandible
m.e., median eye
mx.1., maxillule
mx.2., maxilla
pr., proctodaeum
th.l.1., first thoracic appendage
th.l.3., third thoracic appendage



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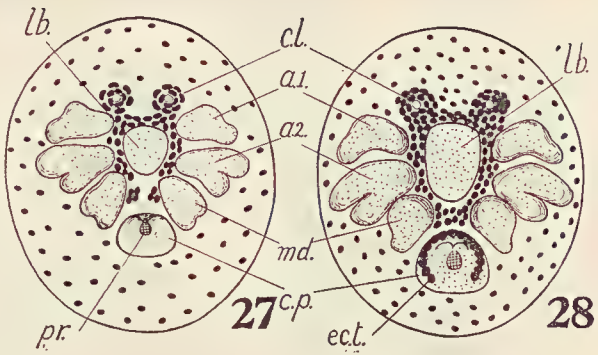

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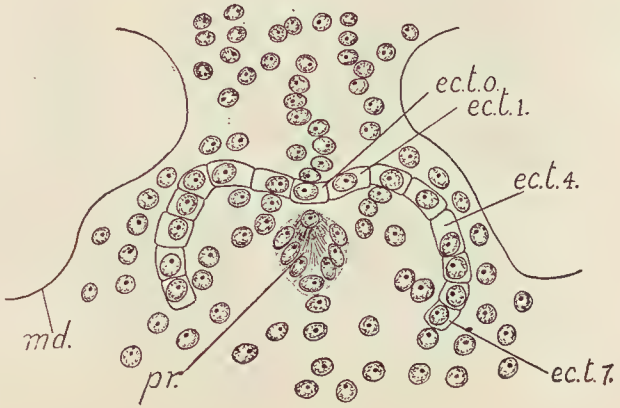

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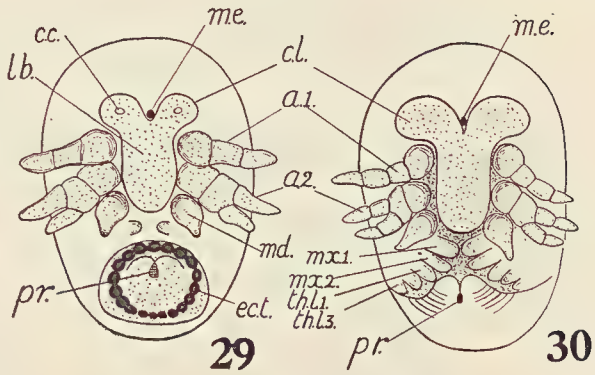

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Plate V

Fig. 31.—Optical section of egg just before hatching, showing the embryo surrounded by the chorion, vitelline membrane, and first and second larval integuments.

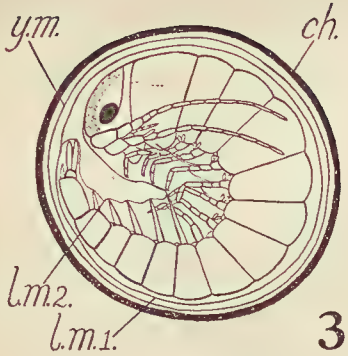
Fig. 32.—Egg at first stage of hatching, showing split in chorion.

Fig. 33.—Second stage in the hatching process. The first larval integument is bulging out through the split in the chorion, forcing it open.

Fig. 34.—Final stage in hatching. The chorion has burst, and the shrimp is now surrounded by the distended first larval integument, to the outer surface of which portions of the vitelline membrane still adhere. The second larval integument has been cast off, and lies within the first.

Fig. 35.—The newly hatched shrimp, showing the sessile eyes, the two pairs of hepatic lobes, and the elongated yolk-sac. The latter is clearly seen through the transparent ectoderm and muscles of the animal.

ch., chorion
*l.m.*1., first larval integument
*l.m.*2., second larval integument
y.m., vitelline membrane



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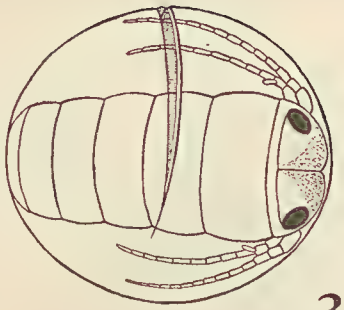

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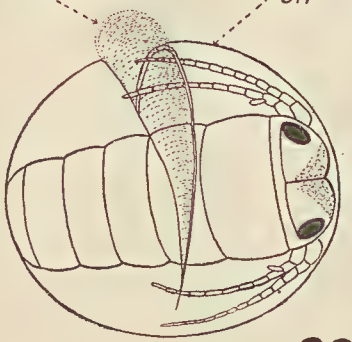

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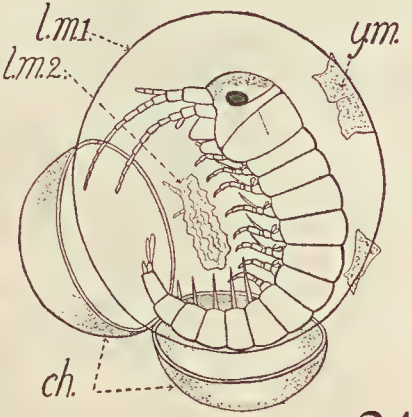

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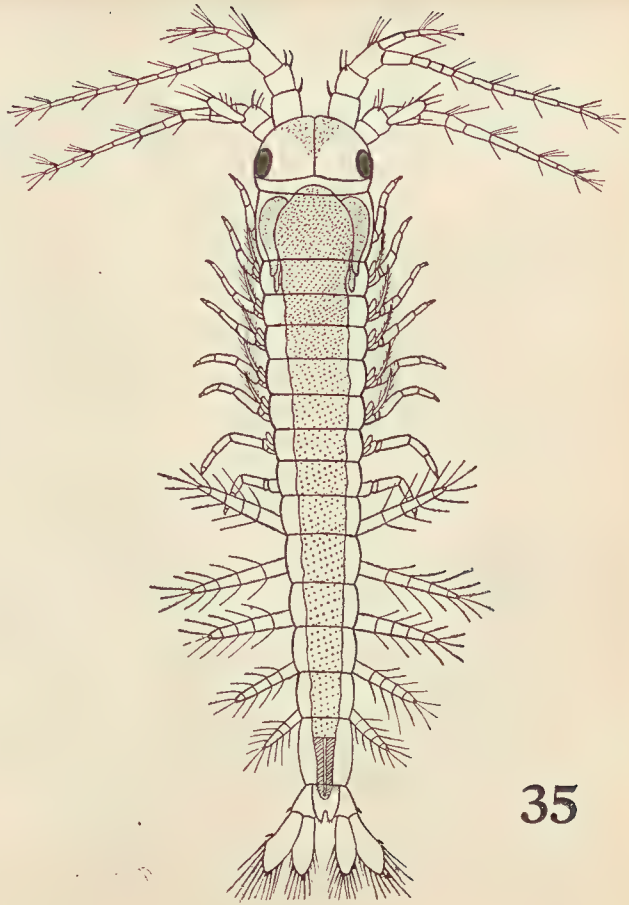

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Plate VI

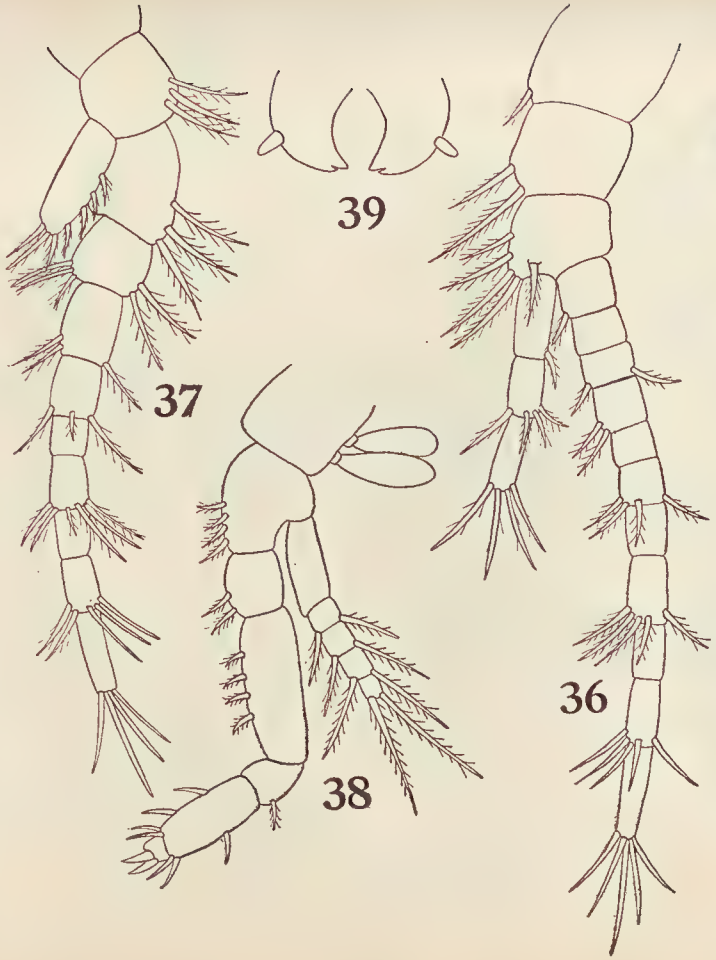
Figs. 36-39.—Appendages of the newly hatched *Anaspides:*

Fig. 36.—Antennule.
Fig. 37.—Antenna.
Fig. 38.—Third thoracic appendage.
Fig. 39.—Mandibles.

Figs. 40-43.—Dorsal views of the head region in young specimens of *Anaspides* to show the gradual development of the rostrum and of the pedunculated condition of the paired eyes:

Fig. 40.—Newly hatched specimen.
Fig. 41.—Specimen about 3·4 mm. long.
Fig. 42.—Specimen about 4·4 mm. long.
Fig. 43.—Specimen about 4·6 mm. long

c.gr., cervical groove
c.s.o., four-celled cervical sense organ
m.gr., median longitudinal groove of head
r., rostrum
r.gr., rostral groove
*th.*2., second thoracic segment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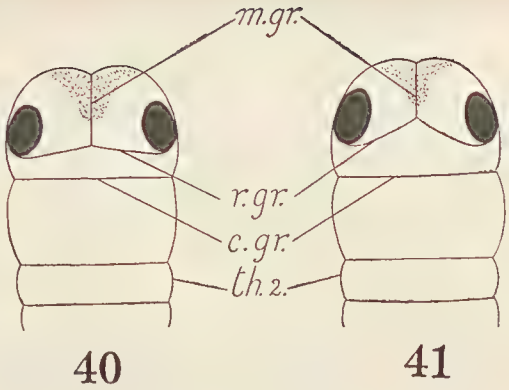
m.gr.
r.gr.
c.gr.
th.2.
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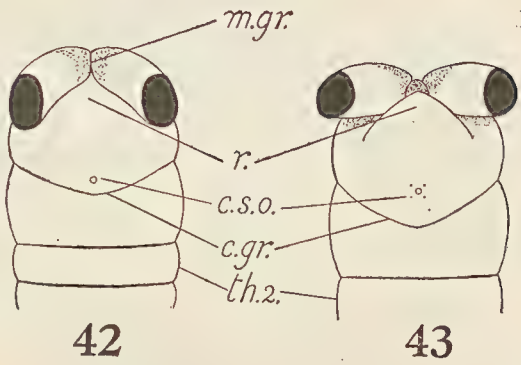
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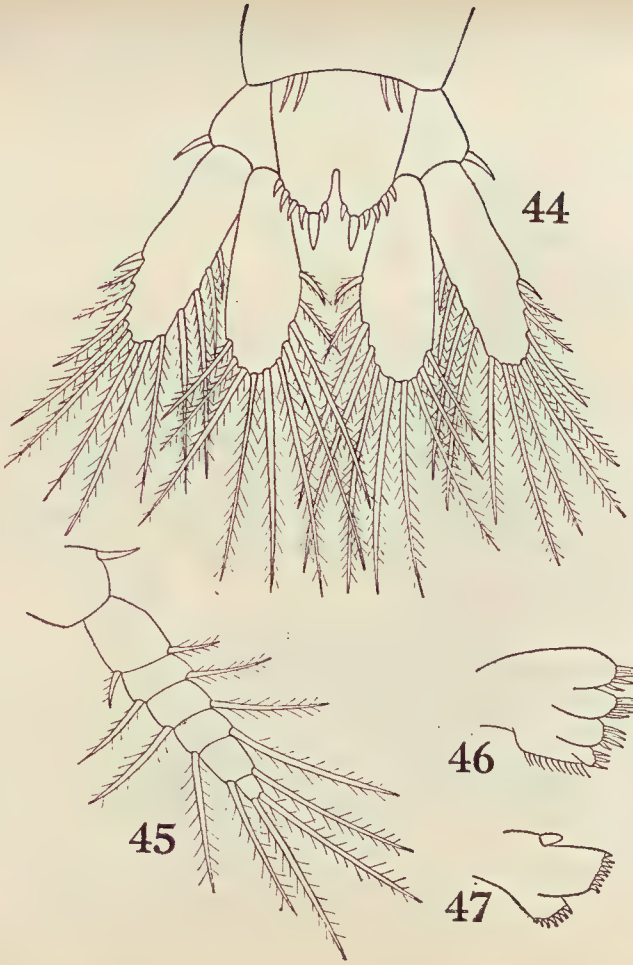
Plate VII

Figs. 44-47.—Appendages and telson of the newly hatched *Anaspides:*
Fig. 44.—Uropods and the notched telson.
Fig. 45.—Third abdominal pleopod.
Fig. 46.—Maxilla.
Fig. 47.—Maxillule.

Fig. 48.—Sagittal section through an embryo at a stage immediately following gastrulation and just before that shown in fig. 21. The endodermal cells have crowded together, and now fill most of the blastocoel. The blastopore is closing, and the cells within its margin form the wall of the proctodaeum. The stomodaeal invagination is commencing. A few mesoderm cells appear below the future position of the labrum.

Fig. 49.—Transverse section of an embryo at the stage shown in fig. 23. The section passes through the opening of the stomodaeum. The strands of mesoderm on each side are seen in cross-section below the rudiments of the antennae. Cytolysis has occurred in some of the endodermal cells, giving rise to granules of chromatin.

a.2., antenna
en., endodermal cell
lb.m., labral mesoderm
n.m., naupliar mesoderm
pr., proctodaeum
st., stomodaeum



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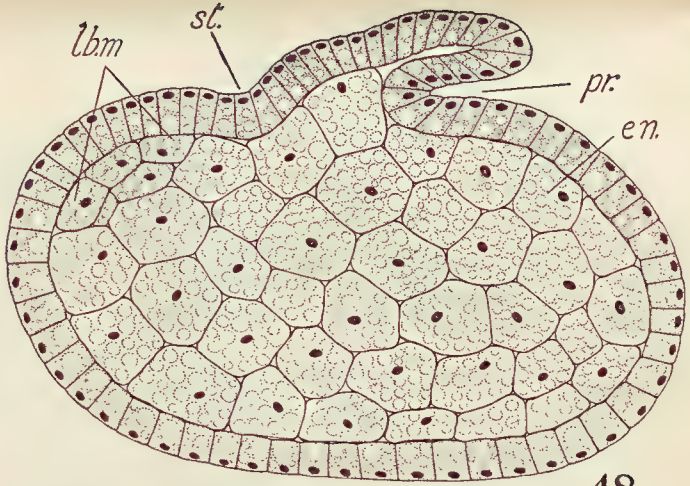

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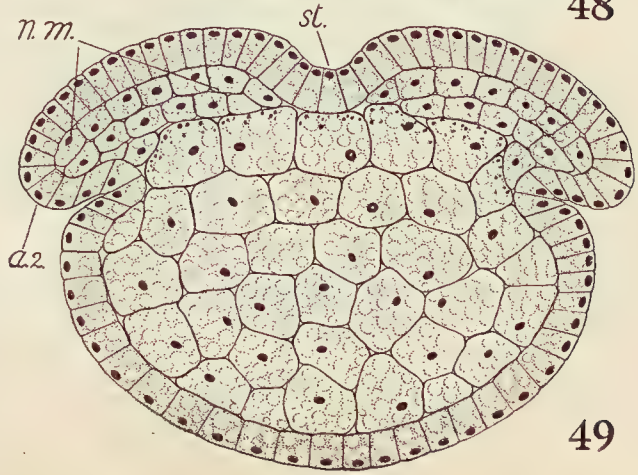


49

PLATE VIII

Fig. 50.—Transverse section of early egg-nauplius passing through the anterior lip of the blastopore. The cells of the posterior ends of the mesodermal strands lie on each side of the proctodaeum. These cells give rise to the mesodermal teloblasts.

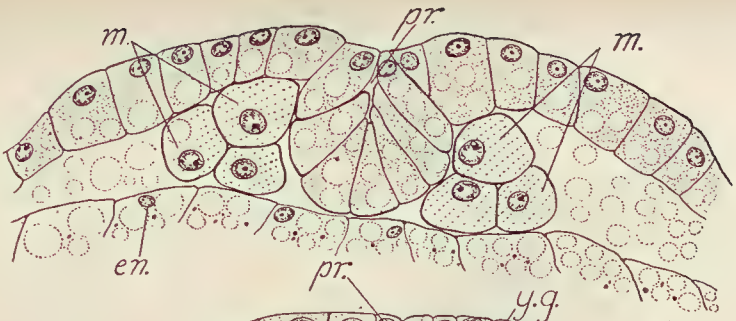
Fig. 51.—Transverse section through the stage shown in fig. 27. The section passes through the caudal papilla, and shows a mesodermal teloblast and its first descendant on each side of the proctodaeum.

Fig. 52.—Transverse section of the nauplius stage shown in fig. 28. The section passes through the caudal papilla, and shows in cross-section on each side the ring of ectodermal teloblasts and two rows of descendants. The mesodermal teloblasts have also given rise to two rows of descendants.

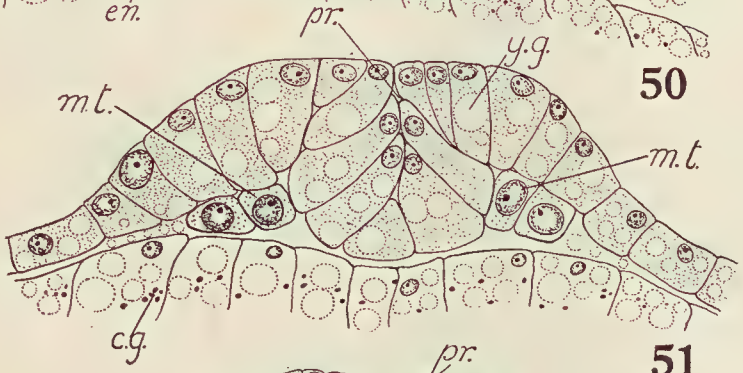
Fig. 53.—Transverse section of the tip of the caudal papilla of an embryo at about the fifteenth week of development. At this stage the papilla cannot be removed from the embryo without injury, and hence had to be sectioned *in situ*. Orientation is not quite correct, and the section is somewhat oblique. It shows the median ectodermal teloblast and several of the lateral ones. The small cells forming the telson mesoderm also appear in the section.

Fig. 54.—Transverse section of the caudal papilla of another embryo of about the same age as that shown in fig. 53. The section is slightly more anterior than that of fig. 53, and shows the four pairs of mesodermal teloblasts and descendants of some of the ectodermal teloblasts.

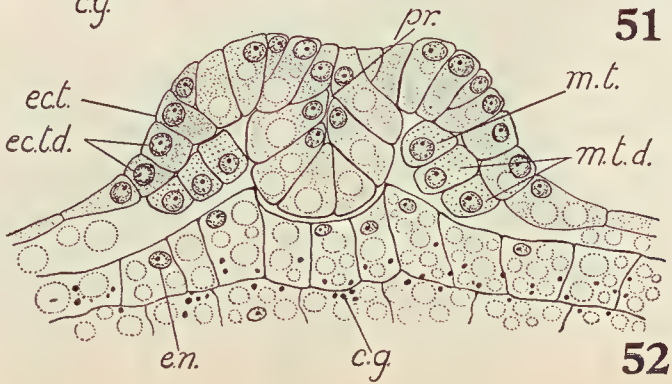
c.g., chromatin granules
ec.t., ectodermal teloblast
*ec.t.*0., median ectodermal teloblast
*ec.t.*1.,-*ec.t.*9., lateral ectodermal teloblasts
ec.t.d., descendant of ectodermal teloblast
*ec.t.*0.*d.*,-*ec.t.*6.*d.*, descendants of median and lateral ectodermal teloblasts
m., primary mesoderm
m.t., mesodermal teloblast
m.t.d., descendant of mesodermal teloblast
*m.t.*1.,-*m.t.*4., the four mesodermal teloblasts of each side
pr., proctodaeum
t.m., telson mesoderm
y.g., yolk granule


m.
pr.
m.
en.

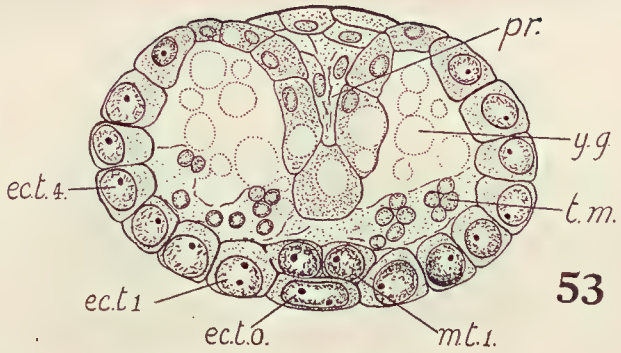
50


pr.
y.g.
m.t.
m.t.
c.g.

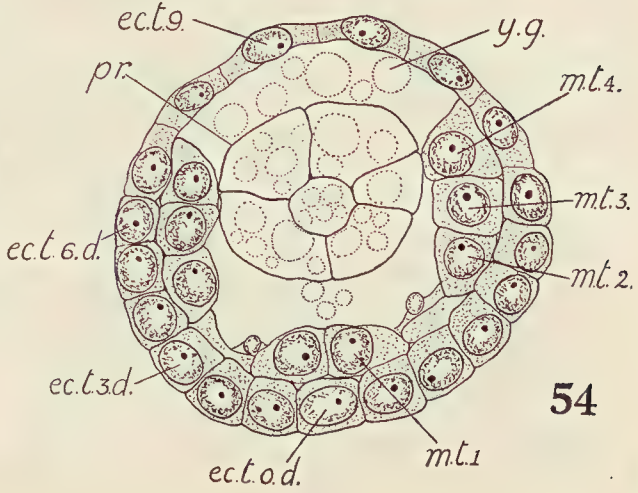
51


pr.
ec.t.
ec.t.d.
m.t.
m.t.d.
e.n.
c.g.

52


pr.
y.g.
ec.t.4.
t.m.
ec.t.1
ec.t.o.
m.t.1.

53


ec.t.9.
y.g.
pr.
m.t.4.
m.t.3.
ec.t.6.d.
m.t.2.
ec.t.3.d.
m.t.1
ec.t.o.d.

54

Plate IX

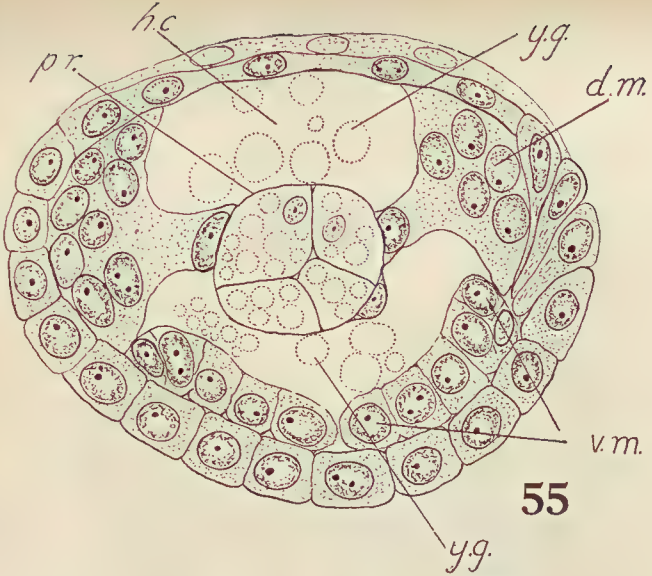
Fig. 55.—Transverse section of the caudal papilla of a 15-week embryo. The section is somewhat further forward than those in figs. 53 and 54. The dorsal and ventral mesoderm are differentiated, and the dorsal mesoderm has commenced its upward growth to form the lateral walls of the dorsal vessel.

Fig. 56.—Transverse section through the third abdominal segment of a 22-week embryo. The walls of the dorsal vessel are now formed, and the pericardial cavity is established by the shrinking away of the mesoderm from the dorso-lateral ectoderm. The floor of the dorsal vessel has been formed by the mesoderm growing over the yolk-sac. Yolk-granules and cells that have spread backward from the naupliar mesoderm are present in the cavity of the dorsal vessel and at the sides of the yolk-sac.

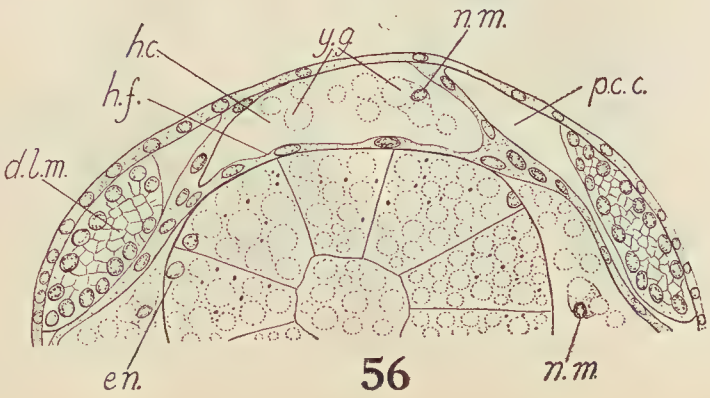
Fig. 57.—Transverse section through the maxillulary somite of a newly hatched specimen, showing the large anterior cavity of the heart roofed over by the dorsal organ.

Fig. 58.—Transverse section through the fourth thoracic somite of a newly hatched specimen, showing the thickened wall of the heart.

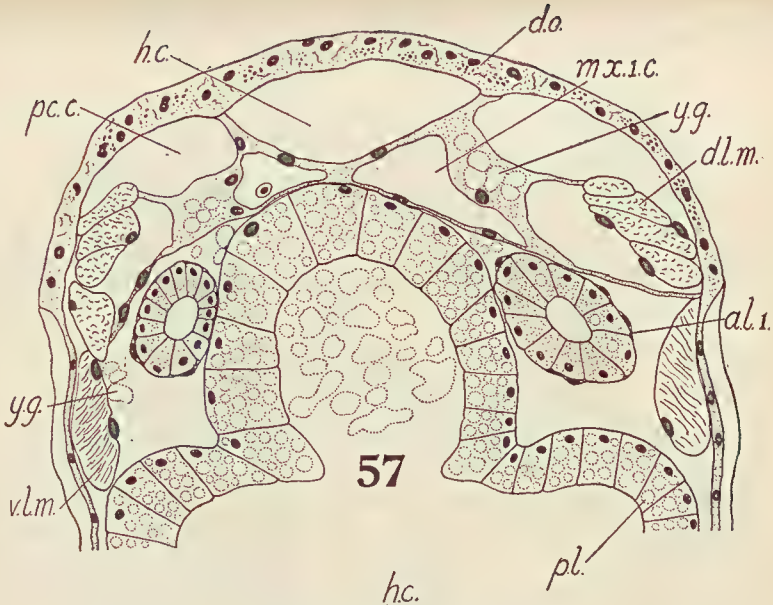
*a.l.*1., primary anterior lobe of liver
d.l.m., dorsal longitudinal muscles
d.m., dorsal mesoderm
d.o., dorsal organ
en., endodermal cell
g., genital rudiment
h.c., cardiac cavity or cavity of dorsal vessel
h.f., floor of cardiac cavity
*mx.*1.*c.*, coelomic cavity of maxillulary segment
n.m., naupliar mesoderm
pc.c., pericardial cavity
pc.f., pericardial floor
p.l., posterior lobe of liver
v.m., ventral mesoderm
v.l.m., ventral longitudinal muscles
y.g., yolk-granules


h.c.
y.g.
p.r.
d.m.
v.m.
y.g.

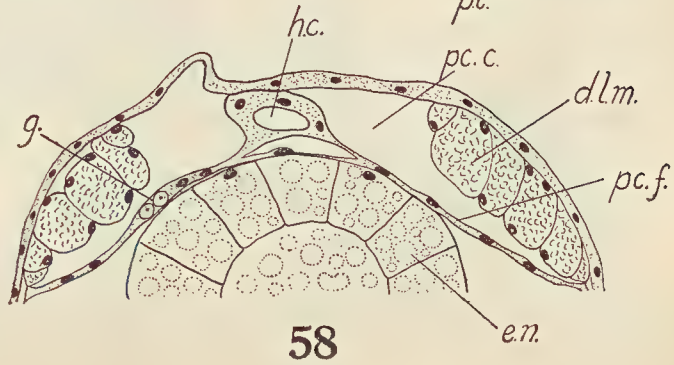
55


n.m.
h.c.
y.g.
h.f.
p.c.c.
d.l.m.
e.n.
n.m.

56


d.o.
h.c.
m.x.1.c.
p.c.c.
y.g.
d.l.m.
a.l.1.
y.g.
v.l.m.
pl.

57


h.c.
p.c.c.
d.l.m.
g.
p.c.f.
e.n.

58

Plate X

Fig. 59.—Transverse section through the fifth abdominal somite of a newly hatched specimen. The section passes immediately in front of the hind-gut, and shows the endodermal cells of the yolk-sac forming the epithelium of the mid-gut, which at this point is completely invested by mesoderm.

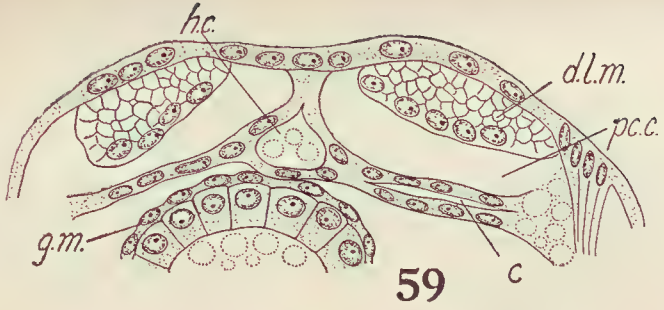
Fig. 60.—Transverse section in front of the stomodaeum of a newly hatched specimen. The anterior aorta and lateral cephalic arteries have appeared in the naupliar mesoderm between the yolk-sac and brain.

Fig. 61.—Sagittal section through an embryo at the stage shown in fig. 23. The stomodaeal invagination reaches almost to the proctodaeum.

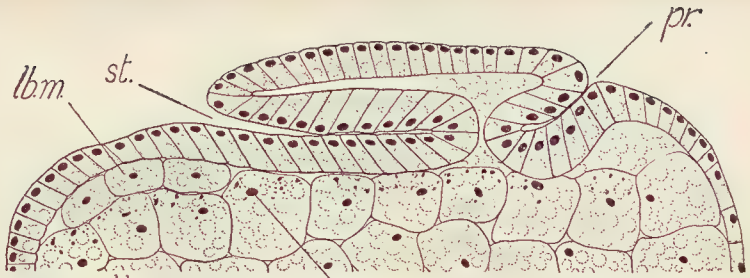
Fig. 62.—Sagittal section through an embryo slightly older than that of fig. 61.

Fig. 63.—Sagittal section through an embryo about as old as that shown in fig. 27. The labrum is growing over the mouth and the posterior end of the stomodaeum is being pulled forward.

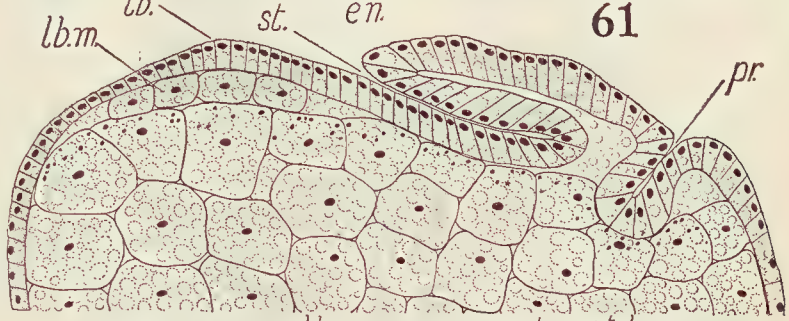
a.a., anterior aorta
b.c., blood corpuscle
br., brain
c., coelomic cavity
c.p., caudal papilla
cu., cuticle
d.l.m., dorsal longitudinal muscles
ec.t.d., descendant of ectodermal teloblast
en., endodermal cell
g.m., mesodermal investment of gut
h.c., cardiac cavity
lb., labrum
lb.m., labral mesoderm
l.c.a., lateral cephalic artery
m.t., mesodermal teloblast
n.m., naupliar mesoderm
pr., proctodaeum
st., stomodaeum


h.c.
d.l.m.
p.c.c.
g.m.
c

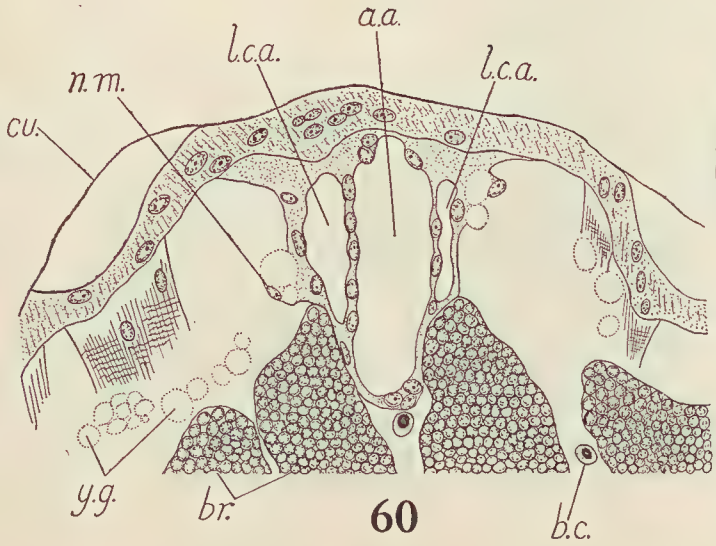
59


pr.
lb.m.
st.
e.n.

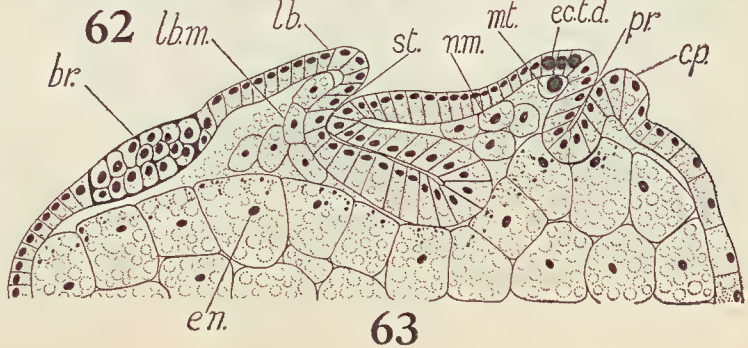
61


lb.
st.
lb.m.
pr.

62


a.a.
l.c.a.
l.c.a.
n.m.
cu.
y.g.
br.
b.c.

60


lb.m.
lb.
st.
n.m.
mt.
ec.t.d.
pr.
cp.
br.
e.n.

63

Plate XI

Fig. 64.—Sagittal section through a 15-week embryo. The caudal flexure occurs just behind the maxillulary somite. The caudal papilla is well developed, and the anal aperture occupies a postero-dorsal position. The end of the stomodaeal invagination now underlies the brain. The yolk-granules in the naupliar mesoderm are being slowly absorbed. The posterior end of the yolk-sac extends into the caudal papilla.

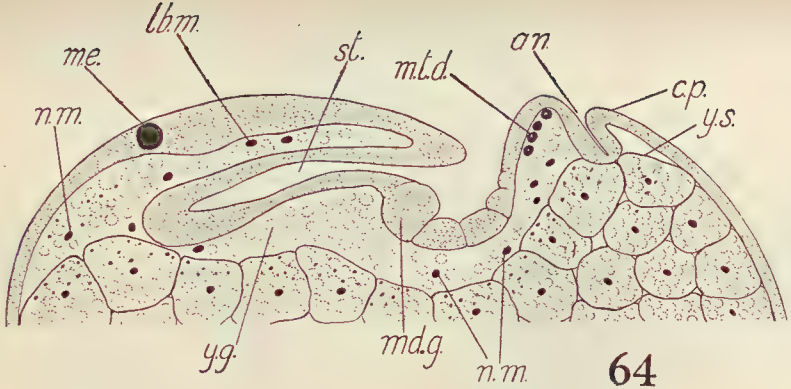
Fig. 65.—An older stage than that of fig. 64. The stomodaeum is now much shorter, the caudal flexure has shifted backwards to the first thoracic somite, and the yolk-sac has become longer. Cells from the naupliar mesoderm have moved backward into the post-mandibular region.

Fig. 66.—Sagittal section through an embryo about 25 weeks old. All somites are now formed. The nerve cord has a seventh abdominal ganglion. Cells which have shifted backward from the naupliar mesoderm are seen below the yolk-sac in the abdomen. Chromatin granules are still present among the yolk-globules of the endoderm.

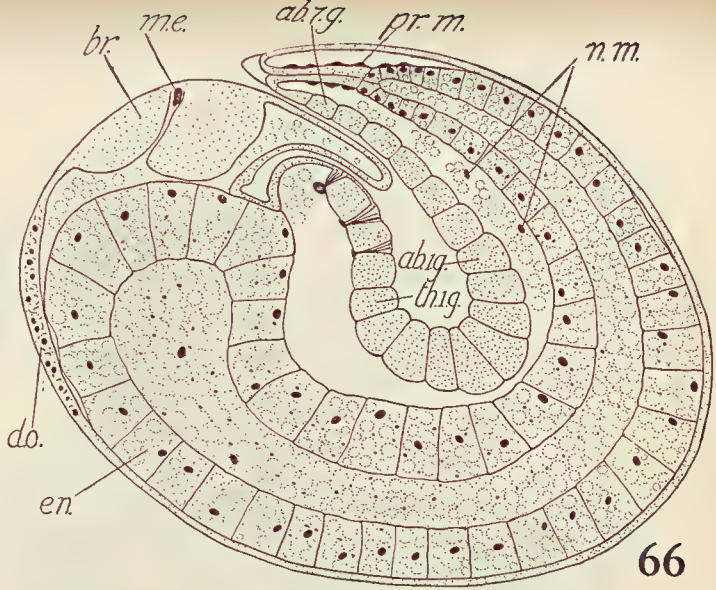
Fig. 67.—Transverse section through the median eye at its first appearance, showing its origin from paired rudiments. Pigment is being deposited in two cells, one on each side of the mid-line.

Fig. 68.—Surface view of the concentric rows of cells in the protocerebrum of an embryo at the stage shown in fig. 29.

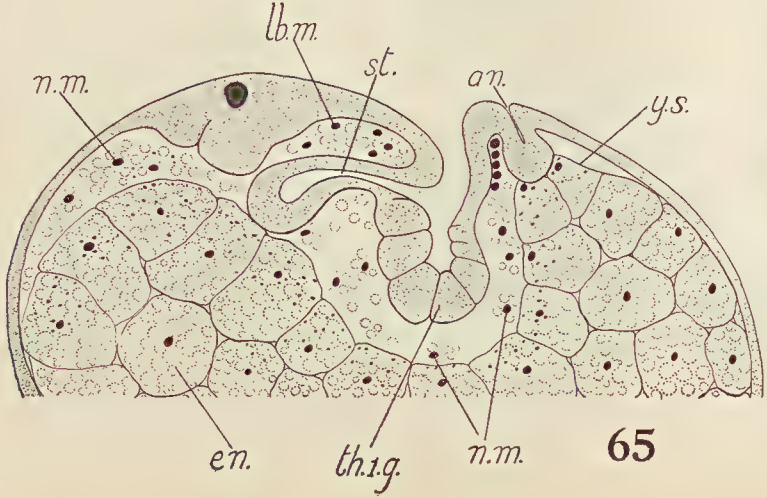
an., anus
*ab.*1.*g.*, first abdominal ganglion
*ab.*7.*g.*, seventh abdominal ganglion
br., brain
c.p., caudal papilla
d.o., dorsal organ
en., endodermal cell
lb., labrum
lb.m., labral mesoderm
md.g., mandibular ganglion
m.e., median eye
n.m., naupliar mesoderm
pr.m., mesodermal investment of proctodaeum
s.t., stomodaeum
*th.*1.*g.*, first thoracic ganglion
y.g., yolk-granule
y.s., yolk-sac


lb.m.
me.
st.
mt.d.
an
c.p.
y.s.
n.m.
y.g.
md.g.
n.m.

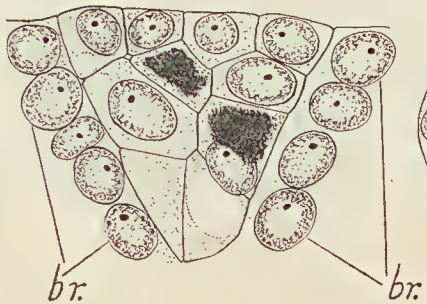
64


br.
me.
ab.1.g.
pr.m.
n.m.
ab.1.g.
th.1.g.
d.o.
en.

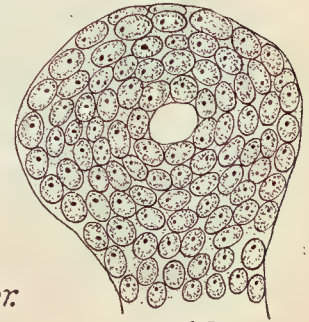
66


lb.m.
st.
n.m.
an.
y.s.
en.
th.1.g.
n.m.

65


br.
br.

67



68

Plate XII

Fig. 69.—Frontal section through the anterior end of an embryo at a late stage of embryonic life. The posterior liver lobes appear as outgrowths of the yolk-sac. They already extend backwards for a short distance, and are capped with mesoderm.

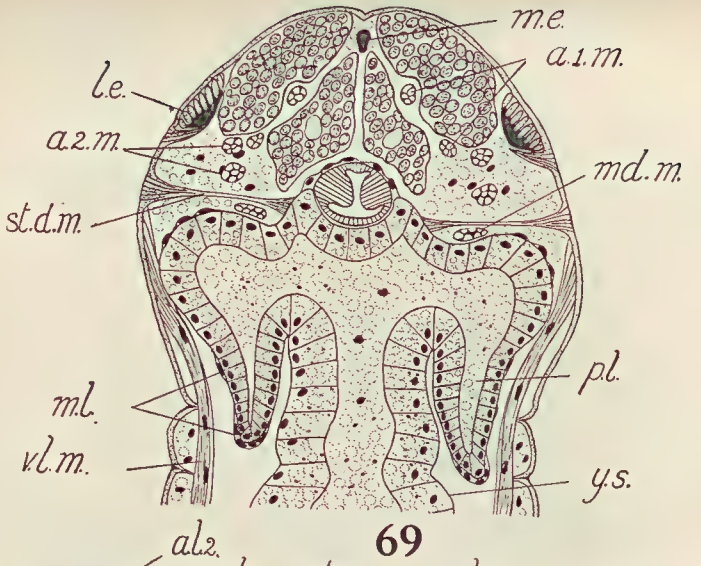
Fig. 70.—A reconstruction of the liver of an embryo about the same age as that shown in fig. 69. The posterior lobe is well developed. The primary anterior lobe has bent over, and is growing backward. The secondary anterior lobe is appearing at the bend in the primary lobe.

Fig. 71.—A reconstruction of the liver of a newly hatched specimen. The posterior lobe is now finger-like. The primary anterior lobe has increased in length, the secondary anterior lobe has bent over and is growing backward, and a third anterior lobe is forming at the bend in the secondary lobe.

Fig. 72.—Transverse section through the sixth thoracic segment of a newly hatched specimen, showing the genital rudiment in the pericardial floor. The coelomic pouch has shrunken and disappeared.

Fig. 73.—Parasagittal section through the fifth thoracic segment of a newly hatched specimen, showing the length of the genital rudiment.

a.1.m., antennulary muscles
a.2.m., antennary muscles
a.l.1., primary anterior lobe of liver
a.l.2., secondary anterior lobe of liver
a.l.3., tertiary anterior lobe of liver
d.l.m., dorsal longitudinal muscles
en., endodermal cell
g., genital rudiment
h.c., cardiac cavity
l.e., lateral eye
m.e., median eye
md.m., dorso-ventral mandibular muscle
m.l., mesodermal investment of liver
pc.c., pericardial cavity
pc.f., pericardial floor
p.l., posterior liver-lobe
st., stomodaeum
st.d.m., dilator muscle of stomodaeum
v.l.m., ventral longitudinal muscles
y.s., yolk-sac


m.e.
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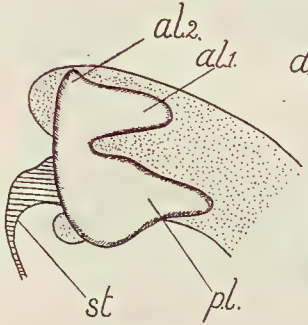
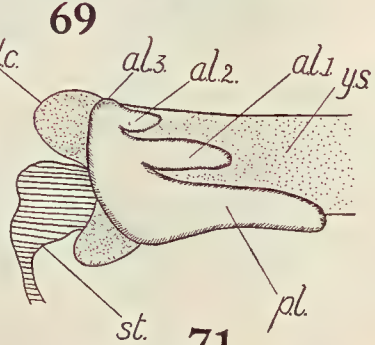
l.e.
a.2.m.
md.m.
st.d.m.
pl.
m.l.
v.l.m.
y.s.

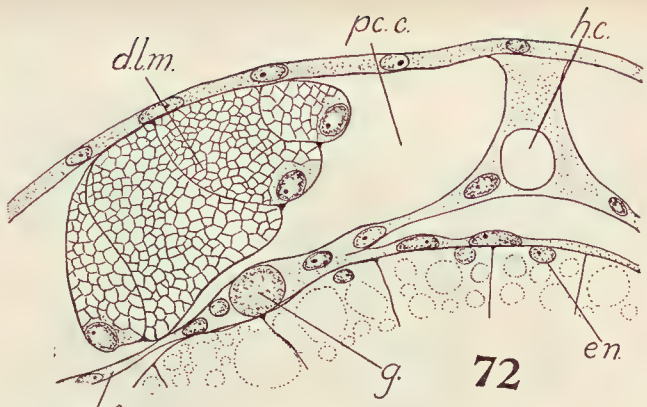
69


al.2.
al.1.
st
pl.

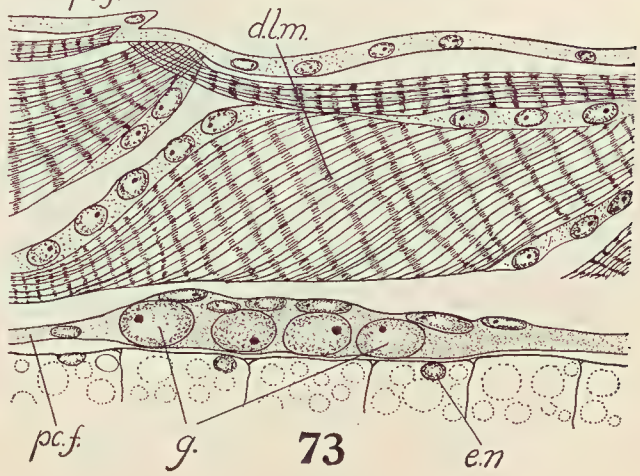
70


d.c.
al.3.
al.2.
al.1
ys
st.
pl.

71


d.l.m.
p.c.c.
h.c.
e.n.
g.
pc.f.

72


d.l.m.
pc.f.
g.
e.n.

73

Plate XIII

Fig. 74.—A sagittal section through the posterior end of the body of a 25-week embryo, showing the seventh abdominal ganglion below the junction of the yolk-sac with the proctodaeum.

Fig. 75.—A later stage than that of fig. 74, showing the sixth abdominal ganglion separated from the fifth. The seventh abdominal ganglion is being pulled into a position above the sixth.

Fig. 76.—An almost sagittal section through the end of the abdomen of a newly hatched specimen, showing the remnant of the seventh abdominal ganglion above the sixth, and separated from it by a slender intersegmental bar.

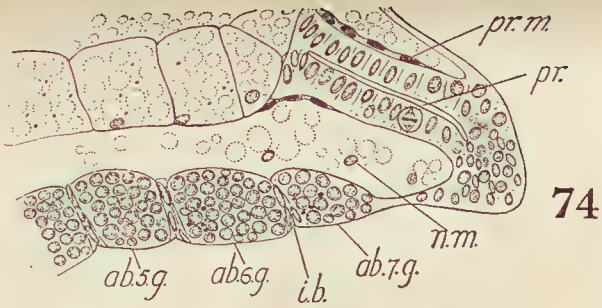
Fig. 77.—Transverse section through the base of the maxillary somite of a 17-week embryo, showing the mesodermal rudiment of the maxillary gland.

Fig. 78.—A slightly later stage than that of fig. 77. The mesodermal cells are becoming oriented transversely to form the tubule of the gland.

Fig. 79.—A sagittal section through the basal segment of the maxilla in a newly hatched specimen, showing the duct of the maxillary gland passing under the adductor muscle and opening by a pore on the posterior surface of the appendage.

Fig. 80.—Section through the lateral part of the maxillary gland of a newly hatched specimen, showing the well-developed tubule cut transversely in several places.

ab.5.g.,-*ab.7.g.*, fifth-seventh abdominal ganglia
i.b., intersegmental ectodermal bar
n.m., cells from the naupliar mesoderm, which have shifted backward into the abdominal region
mx.2., maxilla
mx.g., maxillary gland
mx.g.d., duct of maxillary gland
mx.g.p., external aperture of maxillary gland
mx.g.t., tubule of maxillary gland
mx.t.m., transverse adductor muscle in basal segment of maxilla
n.c., nerve cord
pr., proctodaeum
pr.m., mesodermal investment of proctodaeum
y.g., yolk-granules



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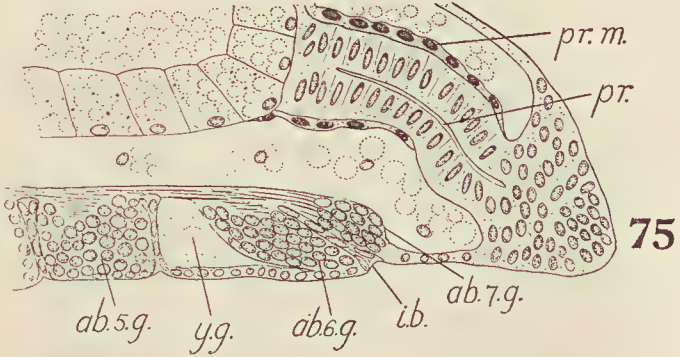

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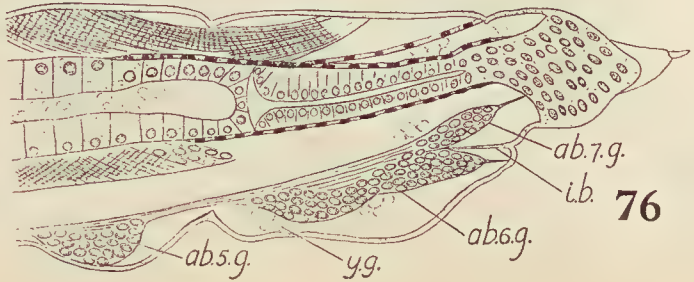
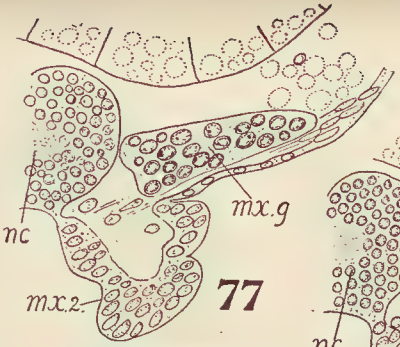


76



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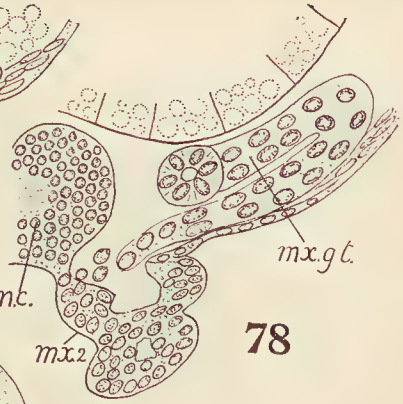

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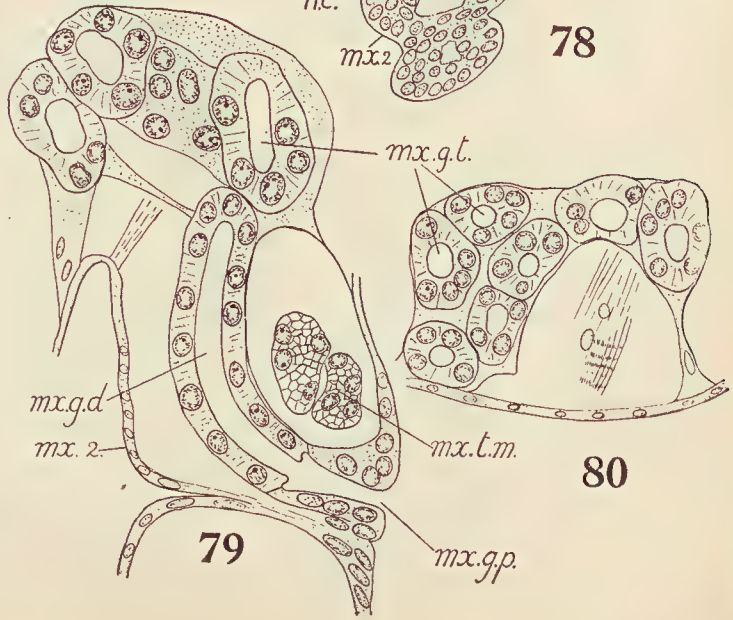

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Australian Leaf-Hoppers (Jassoidea, Homoptera) Part 4*

(Ledridae, Ulopidae, and Euscelidae, Paradorydiini)

By

J. W. Evans, M.A., F.R.E.S.

Plates XIV-XVI

(Read 12th October, 1936)

This paper is concerned with three groups of leaf-hoppers. These are not closely related to each other, but are considered together because of the striking similarity in appearance between certain representatives of each group. This resemblance may be due to the effect of identical environmental factors, to the possession, at least by two of the groups, of a similar inherent orthogenetic trend, or to chance resemblance furthered by parallel evolution.

Family LEDRIDAE

The Ledridae have representatives in Europe, Africa, Asia, and Australia. Although Walker (1851, 1858) described sixteen leaf-hoppers from Australia which he placed in the genus *Ledra* F., it has since been shown that this genus does not occur in the Australian region. The majority of Walker's species belong to another family, the Stenocotidae.

The Ledridae are characterized by the dorsal position of the ocelli, and the structure of the hind tibiae. These are invariably flattened and may be spineless or bear a few short spines on the outer edges. The Australian representatives can be divided into two sub-families, the Ledrinae and the Cephalelinae. Six genera belonging to the Ledrinae have previously been described from Australia. Three new ones are defined below.

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* Previous parts in this series of papers were not numbered, but were published in the following order:

Part 1: A Revision of the Eurymelini. Trans. Roy. Soc. S. Aust. 57, 1933.
Part 2: A Revision of the Ipoinae. Proc. Roy. Soc. S. Aust. 58, 1934.
Part 3: The Bythoscopidae of Australia. Papers & Proc. Roy. Soc. Tas. 1935.

As an aid to the identification of the genera, figures are given of a representative of every genus. These render the provision of a key to the genera unnecessary. The Ledrinae differ from the Cephalelinae in their larger size, and in never having the lateral margins of the pronotum parallel to each other.

Sub-family *LEDRINAE*

The following genera and species of the Ledrinae have previously been described from Australia:

Genus **Ledropsis** White

Ann. & Mag. Nat. Hist. 1 (XIV) ; 425, 1844

In this genus there are four described species, *coccinea* Butler (1874), and *acuminata, crocina,* and *froggatti* Distant (1907). Plate XIV, fig. 1, represents the head and thorax of *Ledropsis crocina.* This species is pale-brown in colour, and the head and anterior half of the pronotum are at a lower level than the scutellum and the hind margin of the pronotum. The venation of the tegmina is recticulate.

Genus **Jukaruka** Distant

Ann. Soc. Ent. Belg. 51 ; 190, 1907

The single species in this genus, *typica* Dist. (1907) (Plate XIV, fig. 2), is closely related to *Ledropsis,* differing principally in the shorter and more truncate head.

Genus **Porcorhinus** Goding

Proc. Linn. Soc. N.S.W. 28 ; 38, 1903

The single species in this genus, *mastersi,* Goding (Plate XIV, fig. 6), was originally described as a membracid, due to the development of lateral margins of the pronotum posteriorly. It is more closely related to *Ledropsis* spp. and *Jukaruka typica* than to species in other genera. *Gudwana* Distant (1907) is a synonym of *Porcorhinus.*

Genus **Ledromorpha** Stål

Ann. Soc. Ent. Fr. 4 (IV) ; 68, 1864

The following species belonging to this genus have been described: *vaginata* Stål (1864), *planirostris* Donovan (1805), *Ledra caudata* Walk. and *Ledra valida* Walker. Both Walker's species are synonymous with *planirostris* Don. *L. planirostris* (Plate XIV, fig. 4) is the largest member of the family occurring in Australia. The female measures 30 mm. from the apex of the head to the tip of the ovipositor.

Genus Petalocephala Stål

Öfv. Vet.-Ak. Förh. 22; 158, 1865

The Australian species, *Ledra brevifrons* Walker (1851), considered by Distant (1907) as belonging to this genus, is unknown to me. Among the generic characters given by Stål are: small eyes; ocelli situated at the foot of the vertex nearer to each other than the eyes; thorax hexagonal, very slightly or not at all narrowed anteriorly. Tegmina sub-coriaceous, transparent, densely punctate, veins branching irregularly against the apex, not quite distinct. (Mr. China informs me that the type specimen of *Ledra brevifrons* is not a true *Petalocephala,* but probably represents a new genus related to *Rubria,* but differing from it in that the head is much shorter than wide across the eyes, and the thorax is shorter and more declivous.)

Genus Rubria Stål

Öfv. Vet.-Ak. Förh. 22, 1865

This genus differs from *Petalocephala,* in that the ocelli are situated behind the middle of the disk of the vertex, the distance between them being equal to or less than their distance from the eyes. Tegmina with five apical cells. Two species are known from Australia, *sanguinea* Stål and *carnosa* Stål (Plate XIV, figs. 3a, 3b, 10). These are probably the commonest members of the family.

Kirkaldy (1906) described seven species of leaf-hoppers, which he placed in the genus *Rhotidus* Walk. (Euscelidae). An examination of the figures accompanying the descriptions suggests that they may all belong to *Rubria* Stål.

Platyledra, gen. nov.

The head is spatulate, narrowing apically to a point; dorsally it is convex, ventrally concave. The lateral sutures of the frons are deep, the lorae depressed, and the clypeus small and pear-shaped. The maxillary plates are narrow. The ocelli are on the dorsal surface, well in front of the eyes, and are closer to the eyes on each side than to each other. There is a well-defined dorsal median longitudinal keel that extends on to the pronotum, and the head, which has in addition irregular small ridges on its dorsal surface, is wider medianly than across the eyes. The pronotum is collar-like and more or less rectangular, the tegmina are coriaceous, the veins raised in relief, and the venation reticulate. The hind tibiae are flattened and spineless, each of the outer edges bearing a fringe of short hairs only. The ovipositor, which extends well beyond the apex of the folded tegmina, is concave ventrally and tectiform dorsally.

Platyledra hirsuta, sp. nov. (Genotype)

(Plate XIV, figs. 5a, 5b)

Length, 17 mm. (from the apex of the head to the tip of the folded tegmina). *Head*, ventral surface, dull yellow, clypeus red, lateral frontal sutures brown. Frons, antennal pits, and clypeus sparsely covered with short white hairs. Dorsal surface of head, pronotum, and scutellum pale brown with dark brown markings. *Tegmen*, grey, veins dark grey. *Thorax* and *abdomen*, ventral surface, and *legs*, pale brown with dark brown markings.

Type ♀, from Ooldea, South Australia (coll. A. M. Lea), in the collection of the South Australian Museum.

Ledrella, gen. nov.

The frons is swollen posteriorly, the antennal ledges distinct and parallel to the hind margin of the ventral surface of the head, the antennal pits shallow, and the maxillary plates narrow. The ventral surface of the head is separated from the dorsal surface by a sharp ridge. Dorsally the head is slightly rounded anteriorly, though not produced, and the ocelli occur just in front of the eyes. The anterior margin of the pronotum is parallel with the dorsal anterior margin of the head, and is narrow laterally and somewhat declivous. The tegmina are evenly rounded apically, and the venation is not recticulate. The hind tibiae are flattened, the outer edges bearing two rows of mobile spines mounted on slightly protuberant bases.

Ledrella brunnea, sp. nov. (Genotype)

(Plate XIV, figs. 9a-9c)

Length, 5 mm. *Head*, *pronotum*, and *scutellum*, pale brown. Head with the ocelli closer to the eyes on each side than to each other. *Tegmen*, transparent; veins brown with white bars. *Thorax* and *abdomen*, ventral surface pale brown with dark brown markings. *Male genitalia*, as in Plate XIV, fig. 9c. The long narrow process, parallel to the aedeagus, is attached to the pygophore, and is not part of the aedeagus, as might appear from the figure.

Type ♂, from Kiata, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Ledraprora, gen. nov.

The head is convex ventrally, and the frons is produced anteriorly into a long narrow process. The maxillary plates are wide and the frons narrow. The ocelli are on the dorsal surface of the head, well in front of the eyes, and face outwards. The pronotum narrows laterally, but the propleurae are sufficiently wide to separate

the head from the bases of the tegmina. The tegmina are evenly rounded apically, and the venation is distinct and not reticulate. The hind tibiae, which are convex on their internal surfaces, are flattened exteriorly, and bear a row of short mobile spines, mounted on slightly protuberant bases, along both the outer edges. In the female the sheath of the ovipositor extends well beyond the apices of the tegmina.

Ledraprora insularis, sp. nov. (Genotype)

(Plate XIV, figs. 7a-7d)

Length, 9·5 mm. *Head*, length of dorsal surface 3·3 mm., width across the eyes 2 mm., brown. The anterior prolongation of the frons has two lateral swellings, is rounded apically, and is keel-shaped both dorsally and ventrally. The ocelli are nearer to each other than to the eyes on each side. *Pronotum* and *scutellum*, pale brown. *Tegmen*, pale hyaline-brown, veins marked with irregular brown and white markings. *Thorax* and *abdomen*, ventral surface, and *legs*, pale brown.

Type ♀, from Kangaroo Island (coll. A. M. Lea), in the collection of the South Australian Museum.

Ledraprora victoriensis, sp. nov.

(Plate XIV, fig. 8)

Length, 10 mm. *Head*, dark brown, the anterior prolongation of the frons more or less circular in section, without lateral swellings. Ocelli closer to the eyes on each side than to each other. *Pronotum* wider laterally than with the genotype, pale brown with dark brown markings. *Scutellum*, pale brown. *Thorax* and *abdomen*, ventral surface pale brown with dark brown markings.

Type ♀, from Kiata, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Sub-family *CEPHALELINAE*

The Cephalelinae comprise a group of small narrow leaf-hoppers that have been recorded from South Africa, Australia, and New Zealand. The following characters will enable their separation from the Parydorydiini, which they superficially resemble:

> The head is produced anteriorly; ocelli, if present, are on the dorsal surface of the head, in front of and between the eyes, frequently they are functionless or even absent. The genae, or that part of the head that lies between the eyes and the frons, may be separated from the maxillary plates by an indistinct transverse suture. The pronotum is collar-like and parallel-sided.

The head, thorax, and tegmina, the lastnamed either proximally only or entirely, are punctate. The tegmina narrow apically, and the venation may be distinct or obscure. Hind wings are absent. The femora are strongly incrassate, and the tibiae distinctly flattened or foliate. The hind tibiae are short and not adapted for jumping. They are feebly spinose along the outer edge.

The available species are placed in four genera, of which two are new.

This group of leaf-hoppers is considered as a sub-family of the Ledridae because of the characters supplied by the elongate head, the dorsal position of the ocelli, and the flattened and feebly spinose hind tibiae. Their nomenclature has been in a state of confusion, partly because of the resemblance of certain species to *Paradorydium* spp., and also because of the uncertainty that existed at one time as to the genotype of *Dorydium* Burm. In addition to the species listed below it is possible that *Dorydium foveolatum* Signoret belongs to the Cephalelinae.

Genus **Cephalelus** Percheron

Mag. Zool. II, 1832

Dorydium Burm., *Hand. Ent.* II, 106, 1835

Genotype *C. infumatus* Perch.

Two species have been described from Australia that belong to this genus, *brunneus* Waterhouse and *marginatus* Waterhouse (1839). The entire dorsal surface of the head is punctate, and the head, which is considerably produced anteriorly, is convex dorsally and evenly concave ventrally. The lateral frontal sutures in the adults terminate at the antennal pits, which are deep, and form a notch in the side of the head, and the eyes are small. The anterior margin of the prothorax is almost straight. The tegmina are long and narrow, coriaceous and sharply pointed apically, and the venation is obscure. The fore and middle tibiae are flattened externally and narrow distally. The hind tibiae are slightly longer, flattened and parallel-sided. Plate XV, fig. 14, represents *Cephalelus brunneus*.

Genus **Notocephalius** Jacobi

Faun. S.W. Aust. Michaelsen u. Hartmeyer ii; 329, 1909

This genus is only known to me from the original description. The figure of the genotype, *Notocephalius hartmeyeri* Jac., that accompanies the description makes it clear that this species is not congeneric with *Cephalelus brunneus*.

Procephaleus, gen. nov.

The head is long, slightly bulbous apically, and more or less circular in cross-section. The ocelli are rudimentary, and the eyes are not prominent. The lateral portions of the anterior margin of the pronotum are not straight, due to the backward prolongation of the eyes. The tegmina are coriaceous, and the venation is distinct. The tibiae resemble those of *Cephalelus* spp.

Procephaleus bulbosa, sp. nov. (Genotype)

(Plate XV, fig. 13)

Length, 8·2 mm. *Head*, width ·8 mm., length 3 mm., ventrally pale brown, dorsally pale brown with dark brown punctures; eyes chocolate-brown. *Pronotum*, concolorous with the head. *Scutellum*, pale brown with a few scattered punctures. *Thorax* and *abdomen*, ventral surface, and *legs*, pale brown.

Type ♀, from Carlisle, Western Australia (coll. D. C. Swan), in the collection of the Australian Museum, Sydney.

Anacephaleus, gen. nov.

The head is produced anteriorly, but is shorter and wider than in the previous two genera, being more or less triangular in shape, flat or slightly rounded dorsally and convex ventrally. The antennal pits are deep. Ocelli may be present or absent and the eyes slightly or very prominent. The prothorax is emarginate laterally. The tegmina are transparent, hyaline or coriaceous and thickened along the anterior costal margin, and the venation is distinct. In addition to the new species described below, *Doryccphalus subreticulatus* Kirk., *D. ianthe* Kirk., and *D. trilineatus* Kirk. (1906) belong to this genus. The figure given by Jacobi of *Paradorydium michaelseni* Jac. (1909) suggests that this species also belongs to the present genus.

Anacephaleus minutus, sp. nov. (Genotype)

(Plate XV, figs. 7a, 7b; Plate XVI, fig. 1)

Length, 3·5 mm. *Head*, width ·8 mm., length of dorsal surface 1 mm., punctate, brown with dark brown markings; labium long, reaching to beyond the bases of the hind legs; clypeus small, pear-shaped; genae separated from the maxillary plates by a transverse suture. Frons parallel-sided, the lateral borders terminating at the antennal pits, which are deep; vertex with a slight median longitudinal ridge; ocelli present, closer to each other than to the eyes on each side. *Pronotum* and *scutellum*, punctate, brown with dark brown markings. *Tegmen*, transparent, punctate basally and along the veins; venation distinct. *Thorax* and *abdomen*, ventral surface, and *legs*, brown.

Type ♀, from Perth, Western Australia (coll. D. C. Swan), in the collection of the Australian Museum, Sydney.

Note.—This species has also been taken on Mount Wellington, Hobart, Tasmania.

Anacephaleus ulopae, sp. nov.

(Plate XV, fig. 9)

Length, 5 mm. *Head,* width across the eyes 1 mm., length 1·2 mm., pale brownish-yellow with brown and white markings; eyes dark brown, prominent; labium reaching to between the middle pair of legs. Ventral surface of head similar to that of the genotype, dorsal surface with rudimentary ocelli and two crescentic prominences between the ocelli and the eyes on each side, and with a median longitudinal ridge. The apex of the head is slightly tilted upwards. *Tegmen,* with reticulate venation; veins distinct, in relief, and the whole surface of the tegmen punctate. The costal margin of the tegmen is rounded, the anal border straight, and the tegmen is pointed apically.

Type ♀, from Adelaide, South Australia (coll. A. M. Lea), in the collection of the South Australian Museum.

Note.—This species bears a close superficial resemblance to *Austrolopa* spp.

Anacephaleus carribensis, sp. nov.

(Plate XV, figs. 8a-8c)

Length, 4 mm. *Head,* width ·7 mm., length 1 mm., pale reddish-brown with dark brown and whitish markings; labium reaching to between the middle pair of legs; clypeus swollen, almost circular, vertex without a median ridge, ocelli rudimentary, closer to each other than to the eyes on each side; eyes prominent. *Pronotum* and *scutellum,* brown, punctate. *Tegmen,* hyaline-brown, punctate basally; veins brown, distinct.

Type ♀, from Carribie, York Peninsula, South Australia (coll. N. B. Tindale), in the collection of the South Australian Museum.

Anacephaleus simplex, sp. nov.

(Plate XV, figs. 10a, 10b)

Length, 7 mm. *Head,* width 1 mm., length 2 mm., pale brown, spatulate, evenly convex ventrally, dorsally with a median longitudinal ridge; ocelli absent; eyes protruding slightly laterally. *Tegmen,* narrow apically, veins brown, distinct, punctate proximally, transparent distally; venation not reticulate.

Type ♀, from Mordialloc, Victoria, in the collection of the National Museum, Melbourne.

Anacephaleus punctatus, sp. nov.

(Plate XV, fig. 12)

Length, 10 mm. *Head*, length 4 mm., slightly concave ventrally; frons ventrally, clypeus, and eyes, chocolate-brown; head dorsally dull brown with dark brown punctures, and with a low but distinct median ridge. Head laterally with a V-shaped indentation adjacent to the antennae; ocelli distinct, white. *Tegmen*, brown, punctate, venation distinct.

Type ♀, from Kiata, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Family EUSCELIDAE

Sub-family *EUPELICINAE*

Tribe *Paradorydiini*

This group of insects is considered here on account of the close resemblance borne by some of its representatives to certain of the Cephalelinae. Among the common characteristics are, in addition to similarities of size, shape, and coloration, the narrow elongate head, absence of hind wings in *Paradorydium* spp., and the punctate head, thorax, and tegmina. They differ in the position of the ocelli, which in the Paradorydiini are situated on the lateral margins of the head, just in front of the eyes, in the venation of the tegmina, and in the structure of the hind tibiae, which have an armature of stout bristle-like spines. In addition the pronotum is never collar-like, and the anterior margin of the pronotum never parallel to the hind margin. The Paradorydiini, which are a tribe of the Euscelidae, are of world-wide distribution. Two genera occur in Australia. These are *Paradorydium* Kirkaldy and *Deltodorydium* Kirkaldy.

Genus **Deltodorydium** Kirkaldy

Bull. Hawaii Sug. Ass. Ent. 3; 73, 1907

This genus (considered a sub-genus by Kirkaldy) is possibly closely related to *Gcaleka* Naudé (1926). The dorsal surface of the head, which is angularly produced, is more or less triangular in shape and flat. The ventral surface is slightly rounded, with the maxillary plates wide, the lateral margins of the clypeus parallel to each other, and the antennal pits shallow. The ocelli are situated on the lateral margins of the head, just in front of the eyes, which are not prominent. The head, pronotum, and scutellum are dotted with shallow punctures. The tegmina are punctate, except at the apices, and the venation is distinct. Hind-wings are present and the hind tibiae bear an armature of strong spines.

Two species belonging to this genus have previously been described from Australia. These are *D. ovidici* Kirk. and *D. brighami* Kirk. (1907). Figure 4, Plate B, which represents the head and thorax of the genotype, *D. brighami*, was drawn from the paratype.

Deltodorydium cooki, sp. nov.

(Plate XV, figs. 1a, 1b; Plate XVI, fig. 2)

General coloration, pale brown. *Length*, 3 mm. *Head*, width 1 mm., pale brown, punctate. *Pronotum* and *scutellum*, pale brown, punctate. *Tegmen*, punctate, excepting apically, venation obscure. Hind tibiae considerably larger than the tibiae of the front and middle pair of legs.

Type ♂, from Adelaide, South Australia (coll. F. Cook), in the collection of the Australian Museum, Sydney.

Deltodorydium viridis, sp. nov.

(Plate XV, figs. 3a, 3b)

Length, 3-3·5 mm., general coloration pale green. *Head*, width 1 mm., punctate; head shorter than with *D. leai*, and without a longitudinal ridge on the vertex ventrally; eyes dark green. *Pronotum*, with the posterior two-thirds a darker green than the anterior third, and wider laterally than in *D. leai*. *Tegmen*, greenish, venation distinct. *Thorax* and *abdomen*, ventral surface, and *legs*, pale green.

Type ♀, from Cannington, Western Australia (coll. M. Solomon on *Melaleuca* sp.), in the collection of the Australian Museum, Sydney.

Note.—Figures are given of two specimens of this species, in order to show the range of variation in the shape of the head.

Deltodorydium leai, sp. nov.

(Plate XV, figs. 2a, 2b)

Length, 3·5 mm., general coloration pale yellowish-brown. *Head*, width 1 mm.; clypeus extending beyond the maxillary plates, lorae not reaching to the anterior margin of the head; vertex with a short, sharp, median, longitudinal ridge extending on to the crown of the head, and from thence on to the pronotum; eyes dark brown. *Tegmen*, punctate, venation distinct.

Type ♂, from Mittagong, New South Wales (coll. A. M. Lea), in the collection of the South Australian Museum.

Genus **Paradorydium** Kirkaldy.

Entomologist 34; 339, 1901

Genotype, *Paradorydium lanceolatum* (Burm.)

The head is punctate and produced, the apex slightly tilted upwards and flattened dorsally. The ventral surface of the head has a median keel, and the dorsal surface, except apically, is rounded, with

or without a median carina. The clypeus is more or less parallel-sided, the maxillary plates wide, and the antennal pits shallow. The ocelli are laterally placed just in front of the eyes. The anterior margin of the pronotum is rounded, the hind border almost straight, and the propleurae wide. The tegmina, which narrow apically, are punctate along the veins, and the venation is distinct. Hind-wings are absent. The hind tibiae have an armature of strong spines similar to those of *Deltodorydium* spp. Two Australian species belonging to this genus have previously been described. These are *Paradorydium menalus* Kirk. and *P. pseudolyricen* Kirk. (1906). The type locality of *menalus* Kirk. is in Northern Queensland. Specimens collected in Victoria (Kiata) and Tasmania (Hobart) so closely resemble this species as not to merit specific differentiation. Plate XV, fig. 6a, represents *P. menalus* Kirk., and fig. 6b the aedeagus of the male. The male genitalia are so similar in general structure to those of *Deltodorydium* spp. as to leave no doubt as to the close relationship existing between the two genera.

Paradorydium casuarinae, sp. nov.

(Plate XV, figs. 5a, 5b)

Length, 6·5 mm. *Head*, width 1 mm., length 2·5 mm., equal in length to the tegmina; pale straminaceous with pale brown punctures, laterally carinate for the entire length of the head. The median dorsal carina does not extend to the apex of the head, which is spatulate; a median ventral carina is also present. *Pronotum*, concolorous with the head, laterally carinate. *Scutellum* with two dark brown spots. *Tegmen* opaque, punctate, venation distinct.

Type ♀, from Canberra, F.C.T. (coll. J.W.E. on *Casuarina* sp.), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Family ULOPIDAE

Austrolopa, gen. nov.

The head ventrally is transversely convex, with a median longitudinal ridge on the vertex; on either side of this ridge is a transverse depression. The frons is very large and flat anteriorly; it projects as a ledge above the clypeus, and its hind margin, which is distinct, lies well away from the hind border of the head; the clypeus is small, and narrows anteriorly. The lorae, which are bounded dorsally by the suture that divides the genae from the maxillary plates, lie for their entire length against the frons, and do not reach as far as the clypeus. The labium reaches as far as the middle pair of legs. The vertex is spatulate, and the crown, dorsally between the eyes, very broad. The eyes are prominent, and ocelli are present. The pronotum is shorter than the crown of the head, and the propleurae extend widely laterally. The scutellum is wide and short.

The tegmina, which are thickened along the anterior costal margin, are short and broad, and narrow apically. The venation is distinct. Hind-wings are absent, and the head, thorax, and tegmina are punctate. The tibiae of all three pairs of legs are quadrilateral in section, and are armed with minute spines.

The two species described below are the first representatives of this family to be recorded from Australia.

Austrolopa brunensis, sp. nov. (Genotype)

(Plate XV, figs. 16a-c)

Length, 4 mm. *Head,* width 1 mm., pale brown, the antennal flagellae dark brown, eyes brownish-grey; crown of head, from above, dark brown with whitish markings. Hind margin of frons distinct and entire; head, from above, not on a plane with the pronotum, but tilted dorsally. *Pronotum,* grey with brown markings. *Scutellum,* dark brown with whitish markings. *Tegmen* marked with an irregular pattern of brown and white. *Thorax* and *abdomen,* ventral surface, pale brownish-yellow. *Legs,* pale brownish-yellow with dark brown markings. Male genitalia as in Plate XV, figs. 16a-c.

Type ♂, from Bruni Island, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Note.—This species has also been taken at Margate, Tasmania, and Brisbane, Queensland.

Austrolopa kingensis, sp. nov.

(Plate XV, figs. 15a-d.; Plate XVI, fig. 3)

Length, 4 mm. *Head,* width 1 mm., ventral surface pale brownish-yellow with irregular dark brown markings; hind margin of frons not complete, the lateral sutures being separated by the median ridge on the vertex, which in this species extends on to the frons. Crown of head on the same plane as the pronotum. *Pronotum* and *scutellum,* pale brownish-yellow, with or without dark brown markings. *Thorax* and *abdomen,* ventral surface, and *legs,* pale brownish-yellow. Male genitalia, aedeagus as in Plate XV, fig. 15d.

Type ♂, from King Island, Tasmania, in the collection of the Australian Museum, Sydney.

Note.—This species has also been taken at Warburton Victoria.

Discussion

Myers (1923), who considered *Cephalelus* and *Paradorydium* to be both genera of the Cephalelinae, was struck, as are all who have seen these insects, by the extraordinary resemblance they bear to

plant spines and seeds. Little is known of their life-history and habits, since they are usually only collected by sweeping. *Paradorydium westwoodi* F. B. White has been collected on rushes in New Zealand; *Cephalelus infumatus* Perch on the rush *Dovea tectorum* in Africa, and *C. hudsoni* Myers and *C. leptocarpi* Myers on the jointed rush *Leptocarpus simplex* in New Zealand. The only host records of Australian species available to me are of *Deltodorydium viridis* on *Melaleuca* sp.; *D. cooki* on the introduced *Echium plantagineum*; *Paradorydium menalus* on grass; *P. casuarinae* on *Casuarina* sp., and *Austrolopa* spp. on grass tussocks. All the species of *Dorydium* described by Naudé (1926) (presumably actually *Paradorydium* spp.) are recorded as being taken by grass-sweeping.

Whilst the short-headed species of the Paradorydiinae are winged, and may occur on shrubs, the fact that all the Cephalelinae and the genera *Austrolopa* and *Paradorydium* have no wings, or wings so ill-developed as to be functionless, suggests that this character is one that is associated with environmental factors. Many other grass-feeding Homoptera (Delphacids and various Jassoid genera belonging to the Euscelidae) lack wings, and may also have reduced tegmina.

The character of a produced head is also one that occurs in many groups of the Homoptera, as, for instance, with the Cercopidae *(Philagra)*, Fulgoridae, Dictyophoridae, and Delphacidae, in addition to several Jassoid genera. The dorsal surface of such elongate heads may consist entirely of the vertex, or of both the vertex and part of the frons. The epicranial sutures, which may be indistinct in adult insects, can usually be distinguished in the nymphs.

Several characters common to *Anacephaleus* and *Austrolopa* suggest that these two genera may be fairly closely related to each other. Amongst those appertaining to the head are the presence of sub-genal sutures; the possession of mandibles which narrow at their proximal ends, and appear to consist of three parts; and of maxillae which are set far back in the head, and are attached to the maxillary apodemes by struts, that arise from the middle of the thickened part of the maxilla (not the end, as in *D. cooki*). With both the clypeus narrows apically. Other common characters are dorsal ocelli, wide sub-genital plates, and hind tibiae with only a few small spines. These characters, combined with others of a more secondary nature, such as lack of hind wings, pronota of similar shape, and similar coloration and general appearance, suggest that species in both genera are not far removed from the stem whence have developed the Ledridae and Ulopidae as distinct families.

I am indebted to Mr. W. E. China, of the British Museum, for assistance in this study.

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Explanation of Plates

Plate XIV

Fig. 1.—*Ledropsis crocina*, head and thorax, dorsal aspect.
Fig. 2.—*Jukuruka typica*, head and thorax, dorsal aspect.
Fig. 3a.—*Rubria sanguinea*, head and thorax, dorsal aspect.
Fig. 3b.—*Rubria sanguinea*, head of nymph.
Fig. 4.—*Ledromorpha planirostris*, head, ventral aspect.
Fig. 5a.—*Platyledra hirsuta*, head, ventral aspect.
Fig. 5b.—*Platyledra hirsuta*, tegmen.
Fig. 6.—*Porcorhinus mastersi*, head and thorax in profile.
Fig. 7a.—*Ledraprora insularis*, head, ventral aspect.
Fig. 7b.—*Ledraprora insularis.*
Fig. 7c.—*Ledraprora insularis*, tegmen.
Fig. 7d.—*Ledraprora insularis*, hind tibia.
Fig. 8.—*Ledraprora victoriensis*, head and thorax, dorsal aspect.
Fig. 9a.—*Ledrella brunnea.*
Fig. 9b.—*Ledrella brunnea*, head and thorax in profile.
Fig. 9c.—*Ledrella brunnea*, male genitalia.
Fig. 10.—*Rubria carnosa*, male genitalia.

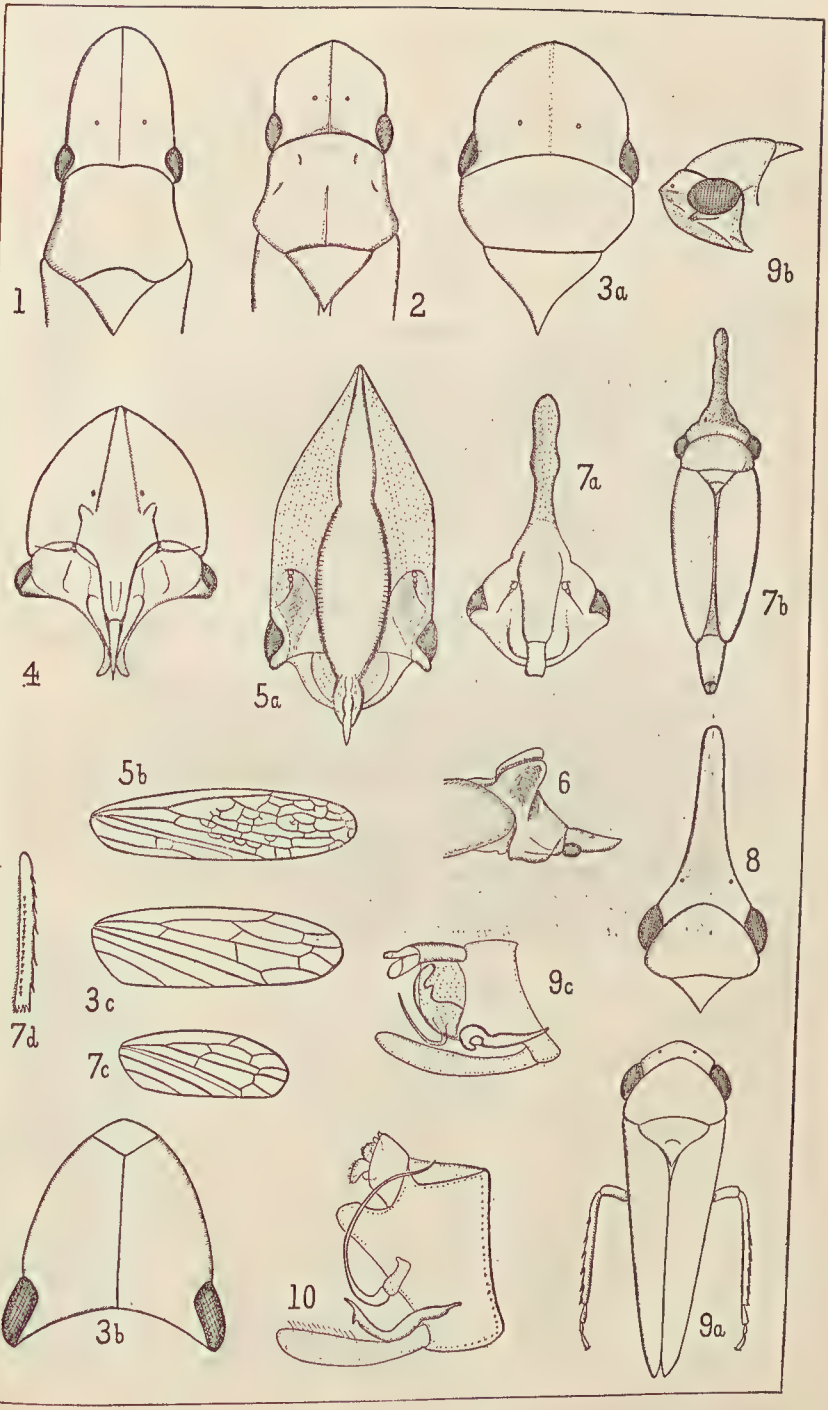
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Plate XV

Fig. 1a.—*Deltodorydium cooki*, head and thorax, dorsal aspect.
Fig. 1b.—*Deltodorydium cooki*, hind tibia.
Fig. 2a.—*Deltodorydium leai*, head and thorax, dorsal aspect.
Fig. 2b.—*Deltodorydium leai*, male genitalia.
Fig. 3a.—*Deltodorydium viridis.*
Fig. 3b.—*Deltodorydium viridis.*
Fig. 4.—*Deltodorydium brighami.*
Fig. 5a.—*Paradorydium casuarinae.*
Fig. 5b.—*Paradorydium casuarinae*, tegmen.
Fig. 6a.—*Paradorydium menalus.*
Fig. 6b.—*Paradorydium menalus*, aedeagus.
Fig. 7a.—*Anacephaleus minutus*, head and thorax, dorsal aspect.
Fig. 7b.—*Anacephaleus minutus*, male genitalia.
Fig. 8a.—*Anacephaleus carribensis*, head and thorax, dorsal aspect.
Fig. 8b.—*Anacephaleus carribensis*, head, ventral aspect.
Fig. 8c.—*Anacephaleus carribensis*, hind tibia.
Fig. 9.—*Anacephaleus ulopae*, head and thorax. dorsal aspect.
Fig. 10a.—*Anacephaleus simplex*, head and thorax, dorsal aspect.
Fig. 10b.—*Anacephaleus simplex*, tegmen.
Fig. 11.—*Anacephaleus subreticulatus.*
Fig. 12.—*Anacephaleus punctatus*, head and thorax in profile.
Fig. 13.—*Procephaleus bulbosa*, head and thorax, dorsal aspect.
Fig. 14.—*Cephalelus brunneus.*
Fig. 15a.—*Austrolopa kingensis.*
Fig. 15b.—*Austrolopa kingensis*, hind tibia.
Fig. 15c.—*Austrolopa kingensis*, tegmen.
Fig. 15d.—*Austrolopa kingensis*, aedeagus.
Fig 16a.—*Austrolopa brunensis*, paramere.
Fig 16b. —*Austrolopa brunensis*, aedeagus.
Fig 16c.— *Austrolopa brunensis*, sub-genital plate.

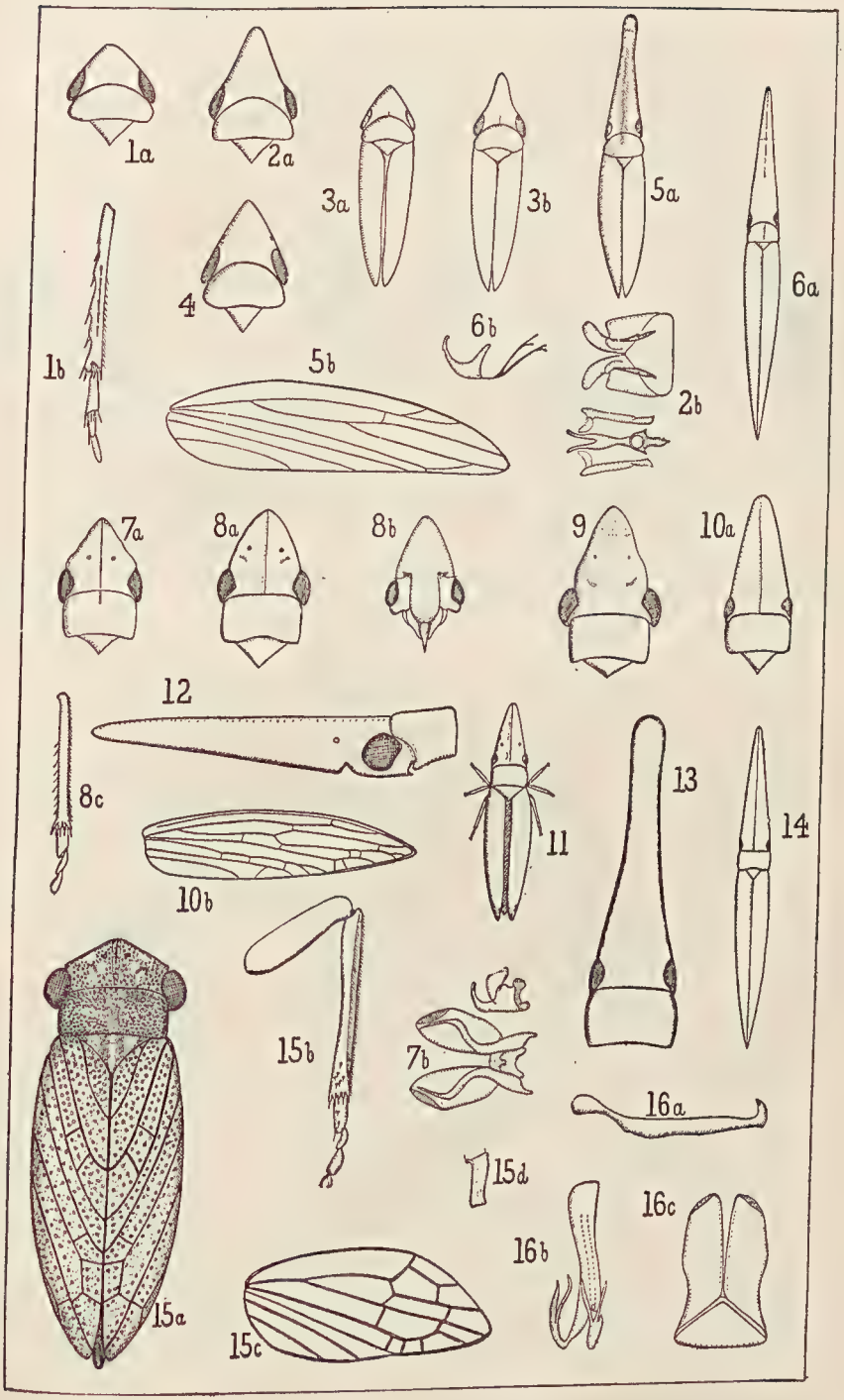
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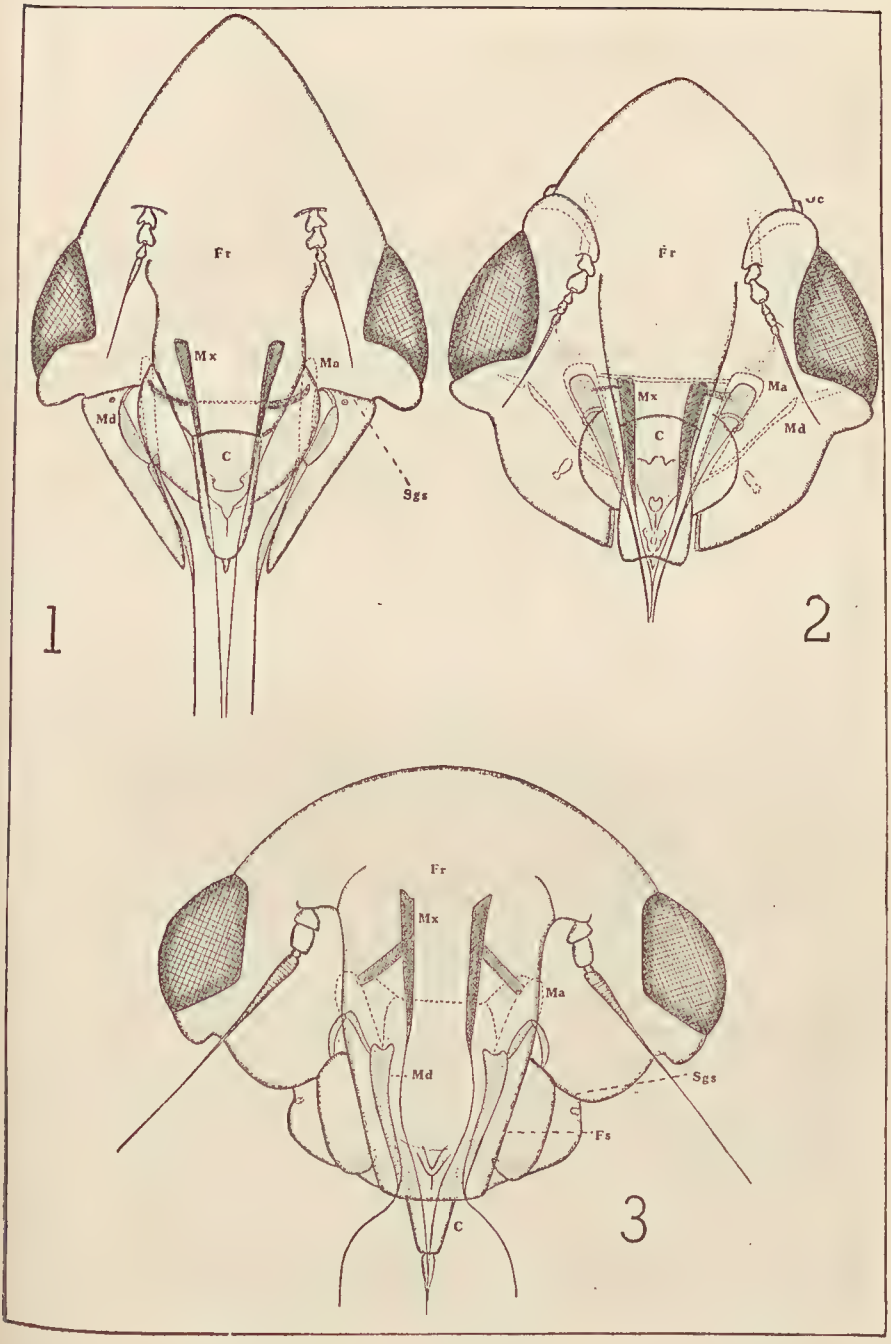
Plate XVI

Fig. 1.—*Anacephaleus minutus*, head, ventral aspect.
Fig. 2.—*Deltodorydium cooki*, head, ventral aspect.
Fig. 3.—*Austrolopa kingensis*, head, ventral aspect.

c., clypeus
fr., frons
fs., frontal suture
mx., maxilla
md., mandible.
oc., ocellus
sgs., subgenal suture
ma., maxillary apodeme.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Pap. & Proc. Roy. Soc. Tasmania, 1936 (31st May, 1937)

Australian Leaf-Hoppers (Jassoidea, Homoptera)
Part 5
Euscelidae (in part)

By

J. W. Evans, M.A., F.R.E.S.

Plates XVII-XIX

(Read 12th October, 1936)

This paper is concerned with the species and genera of two of the tribes of the Euscelinae that occur in Australia. All the species dealt with are arboreal; the majority are confined to eucalyptus trees, and all are relatively large, ranging from 5 to 15 mm. in length. The other genera comprised in this sub-family consist mostly of grass-feeding species; these will be dealt with in a future publication.

The principal purpose of this paper is to render possible the generic identification of the insects considered, and to show the interrelationships between the genera. It has been found impossible to include a redescription of every named species, or even to determine the full extent of the existing synonymy.

The Euscelidae differ from other Jassoid families, in that the apex of the frons is confined entirely to the under-surface of the head, except in some instances for a very narrow border. The vertex occupies all, or nearly all, the upper surface of the head; the ocelli are on, or near, the upper margin of the head, and the suture between the vertex and frons is occasionally not visible. The hind tibiae are strongly flattened, with four rows of fairly long spines along each angle, one row with the spines much thicker and farther apart than in the other rows.

There are three sub-families, the Euscelinae, Balcluthinae, and Eupelicinae. The Balcluthinae are represented in Australia by only two genera, *Pettya* Kirk. and *Nesosteles* Kirk. They are characterized

by the very long tegmina, which are more than twice the length of the claval commisure. The Eupelicinae may be divided into two tribes, the Eupelicini and the Paradorydiini. Of these only the Paradorydiini occur in Australia, and are represented by two genera, *Paradorydium* Kirk. and *Deltodorydium* Kirk. The Australian arboreal Euscelinae may be separated into two tribes, which are defined in the following key:

Tegmen with a broad appendix that continues widely round the apex of the tegmen; ambient vein of wing continuing on to the claval area .... *Tartessusini*

Tegmen with or without a small narrow appendix; ambient vein of wing terminating at the claval suture .... *Thymbrini*

Key to the Genera of the Tartessusini

1. Labium short, not reaching to between the hind legs 2
   Labium long, reaching to between the hind legs .... *Tartessoides*, gen nov.
   Genotype, *Tartessoides griseus*, sp. nov.
2. Lateral margins of frons, in ventral aspect, straight .... *Tartessella*, gen. nov.
   Genotype, *Tartessella attenuata*, sp. nov.

   Lateral margins of frons, in ventral aspect, curved posteriorly towards the eyes .... *Tartessus* Stål
   Genotype, *Tartessus ferrugineus* Walk.

Tribe TARTESSUSINI

Tartessus Stål

Öfv. Vet.-Ak. Förh. 22; 156, 1865

This genus contains more species than any of the other genera comprised in both the Tartessusini and Thymbrini. It is not confined to Australia, but extends to New Caledonia, New Guinea, Mysol, the Phillipines, and Cambodia. The following species have previously been described from Australia: *fulvus* Walk., *latifrons* Walk., *australis* Walk., *transversus* Walk. (1851), *semicitrinus* Walk., *signifrons* Walk. (1858b); *australicus* Spanberg, *flavipes* Spanberg (1878); *subniger* Sign., *sahlbergii* Sign. (1880); *syrtidis* Kirk. (1906), *idyia* Kirk., *itonias* Kirk., *issa* Kirk., *iphis* Kirk., *io* Kirk., *ianthe* Kirk., *iambe* Kirk., *ianeira* Kirk., *ianassa* Kirk., *iokaste* Kirk. (1907); *occidentalis* Jac. (1909). Several species are synonymous with *Tartessus fulvus*, and in addition an examination of the paratypes of Kirkaldy's species has shown that *io* is synonymous with *ianthe*, and *ianassa* with *iokaste*. All Walker's species were originally placed in the genus *Bythoscopus*. The same author also described a *Coelidia australis* (1851), which, according to Distant (1908), belongs to the genus *Tartessus*. Mr. China informs me that Distant was in error.

The head may be almost flat or slightly convex, the maxillary plates wide, and the clypeus broad, in some species widening anteriorly. The frons widens posteriorly, and in some species consists of two distinct regions: an anterior oval area, bearing the

transverse muscle impressions, and a posterior rectangular area. These two regions may be especially distinct in the nymphs (see Appendix). The hind margin of the frons is distinct, and may be ventral, marginal, or dorsal in position. The ocelli lie between the lateral borders of the frons and the eyes, close to the former. The antennal ledges are distinct, but not pronounced, and the antennal pits shallow. The eyes are large, but not prominent, and the crown of the head in dorsal aspect is wide. The pronotum is produced anteriorly; the anterior border is never parallel with the hind border, and laterally it is narrow. The tegmina have a very wide appendix that continues round the apices of the tegmina, and the ambient vein of the hind wing continues on to the claval area. Many species have one or a few spines on the hind margin of the tegmen arising from the point of commencement of the appendix. The hind tibiae have an armature of strong spines. The rows of largest spines are mounted on enlarged bases, and between each of these are from three to five short, strong spines. In addition there are two rows of strong spines, of which one row comprise longer spines than the other; these may be of unequal lengths. There is also a row of long, hair-like spines. The male genitalia have large pygophores, which bear style-like processes on the internal dorsal margin.

Tartessus fulvus (Walk.)

(Plate XVII, figs. 1a-1e)

Bythoscopus fulvus Walk., *List Homopt.* III, 866, 1851
Bythoscopus latifrons Walk., *op. cit.* 869
Bythoscopus transversus Walk., *op. cit.* 869
Bythoscopus semicitrinus Walk., *Ins. Saund. Homopt.*, 105, 1858
Bythoscopus signifrons Walk., *op. cit.* 106
Tartessus australicus Spanberg, *Öfv. Vet.-Ak. Förh*, 351, 1878
Tartessus subniger Sign. *Ann. Soc. Ent. Fr.* 5 (X), 350, 1880
Tartessus syrtidis Kirk., *Bull. Hawaii Sug. Aus. Ent.* 1 (9), 541, 1906

This species is redescribed here, in spite of the fact that an excellent description was given by Signoret in 1880, because it is by far the most abundant species of the genus *Tartessus* that occurs in Eastern Australia. It is variable as regards coloration, hence the existing synonymy. Numerous figures are given for the purpose of illustrating a typical species belonging to this genus.

Length (from the apex of the head to the tip of the folded tegmina), 9 mm. *Head*, width 2·5 mm. ventral surface whitish-yellow with black markings, eyes greyish-brown, ocelli marginal; crown whitish-yellow, wider against the eyes than in the centre. *Pronotum*, anterior border whitish-yellow, the remainder pale yellowish-brown. *Scutellum*, pale yellowish-brown with brown markings. *Tegmen*, hyaline-brown, veins brown. There are two spines on the anal

margin. *Thorax* and *abdomen*, ventral surface, black. *Legs*, coxae black; femora, proximally black, distally pale yellowish-brown; tibiae and tarsi, pale yellowish-brown.

Tartessus obscurus, sp. nov.

(Plate XVII, figs. 5a-5b)

Length, 5 mm. *Head*, width 1·4 mm., pale brownish-yellow, eyes black, head rounded posteriorly, the ocelli, but not the hind margin of the frons, visible in ventral aspect; crown of head from above, slightly produced between the eyes. *Pronotum* and *scutellum*, pale brown; the scutellum is longer than the pronotum. *Tegmen*, pale hyaline-brown, with one spine on the hind margin. *Thorax* and *abdomen*, ventral surface, and *legs* pale brownish-yellow.

Male genitalia, aedeagus as in Plate XVII, fig. 5b.

Type ♂, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Tartessus mackerrasi, sp. nov.

(Plate XVII, figs. 4a, 4b)

Length, 6 mm. *Head*, width 1·9 mm., ventral surface black, but for the hind border of the frons and vertex and antennal ledges, which are brown; eyes, dark reddish-brown; crown from above, brown. *Pronotum* and *scutellum*, pale brown, the former slightly longer than the latter. *Tegmen*, hyaline-brown, veins dark brown; a single short spine on the hind margin. *Thorax* and *abodmen*, ventral surface, black. *Legs*, black, but for the tibiae and tarsi of all three pairs of legs, which are marked with a pattern of light and dark brown.

Male genitalia, aedeagus as in Plate XVII, fig. 4b.

Type ♂, from Canberra, F.C.T. (coll. I. Mackerras), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Tartessus pallidus, sp. nov.

(Plate XVII, fig. 7)

Length, 6·5 mm. *Head*, width 2 mm., ventrally very pale brownish-yellow, clypeus and markings on the frons pale brown; eyes, brownish-red. Head, dorsally pale brownish-yellow, slightly produced anteriorly. *Pronotum* and *scutellum*, tawny. *Thorax*, ventral surface, and *legs*, very pale brownish-yellow. *Abdomen*, chocolate-brown.

Type ♀, from Sydney, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Tartessus blundellensis, sp. nov.

(Plate XVII, fig. 6)

Length, 9·5 mm. *Head*, width 1·9 mm., ventrally pale coffee-coloured with whitish markings, but for the clypeus, which is pale straminaceous; eyes, reddish-brown. Dorsal surface of the head with the hind margin of the frons broadly visible. *Pronotum*, pale coffee-coloured with irregular whitish markings. *Scutellum*, dull olive-brown. *Tegmen*, pale hyaline-brown, the veins brown tinged with purple; hind border with a group of four spines. *Thorax* and *abdomen*, ventral surface, and *legs*, pale straminaceous, but for the bases of the spines on the hind tibiae, which are dark brown.

Type ♀, from 'Blundells', F.C.T. (coll. J.W.E.), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Tartessus spinosus, sp. nov.

(Plate XVII, fig. 8)

Length, 6·5 mm. *Head*, width 2·5 mm.; frons and vertex pale brown with dark brown markings; clypeus, maxillary plates, and lorae, pale greyish-brown. *Pronotum*, very pale yellowish-brown mottled with grey. *Scutellum*, pale yellowish-brown with dark brown markings. *Tegmen*, colourless, hyaline; veins distinct, brown. *Thorax* and *abdomen*, ventral surface, pale brown with dark brown markings. *Legs*, pale brown with dark brown markings, excepting the hind tibiae, which are pale yellowish-brown, and the bases of the spines, which are black; femora and tibiae of front two pairs of legs covered with short, sharp spines; hind femora smooth.

Male genitalia, aedeagus short (Plate XVII, fig. 8), pygophores with a divided process attached to the dorsal margin anteriorly; sub-genital plates covered externally with strong spines, each spine having a black base. *Ovipositor*, with the outer sheath covered with short, sharp spines.

Type ♂, from Carnac Island, Western Australia (coll. K. Norris, on *Anthocerus littorea*), in the collection of the Australian Museum, Sydney.

Tartessoides, gen. nov.

The head as seen from below is triangular in shape; the clypeus is widest in the middle and narrowest at the anterior margin. The frons widens posteriorly, the hindmost third having a median ridge and two lateral depressions. The labium is long, reaching as far as the hind coxae, the antennal pits are deep, eyes prominent, and the ocelli are situated at the corners of the posterior margin of the frons, just below the ventral hind border of the head. In dorsal

aspect the crown is wide. The pronotum is depressed anterolaterally and raised medianly; the depressed portion is more or less smooth and the elevated portion transversely striated. The apex of the scutellum is raised into a slight hump. The tegmina are long and narrow, the appendix continues widely round the apex of each tegmen, and the veins are somewhat curved (not straight, as with *Tartessus*). The wings have the ambient vein continuing on to the anal area, and the armature of the hind tibiae is similar to that of *Tartessus*.

Tartessoides griseus, sp. nov. (Genotype)
(Plate XVII, figs. 9a-9c)

Length, 10 mm. *Head*, width 2·5 mm., grey mottled with light and dark brown; eyes, brownish-yellow spotted with black. *Pronotum*, grey with very dark brown markings. *Scutellum*, grey barred with black and with a few round black spots. *Tegmen*, hyaline-grey, veins very dark brown; many of the cells with irregularly-shaped dark brown and black areas. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown with dark brown markings.

Type ♀, collected between the Everard Ranges, South Australia, and the Warburton Ranges, West Australia (coll. A. Brumby), in the collection of the South Australian Museum.

Tartessella, gen. nov.

Head from below, lorae small and narrow, the clypeus pear-shaped, and the labium short, reaching as far as the front pair of legs. The frons widens posteriorly, the hind margin being situated at the edge of the dorsal border of the head. The ocelli lie just below the dorsal border of the head, in the corners between the lateral margins of the frons and the ridge that separates the dorsal from the ventral surface of the head. The crown in dorsal aspect is wide and flat, and is wider against the eyes than in the middle. The pronotum is heart-shaped, almost flat, and transversely striated. The venation of the tegmina and of the wings is similar to that described for *Tartessoides griseus*, and the armature of the hind tibiae similar to that of *Tartessus*, but differs in that the small spines that are inserted between the large ones may be few in number and long and delicate instead of short and strong. The pygophores of the male genitalia lack a process.

Tartessella attenuata, sp. nov. (Genotype)
(Plate XVII, figs. 10a-10c)

Length, 11 mm. *Head*, width 2·8 mm., ventral surface pale brown with transverse brown markings on the frons, the vertex mottled with dark brown, and the eyes dark brown. *Pronotum*, dull greyish-brown, with indistinct whitish maculations. *Scutellum*, dull brown.

Tegmen, hyaline, veins brown, with no incomplete cross-veins and no cross-veins on the anal area. *Thorax* and *abdomen*, ventral surface, pale brown. *Legs*, fore and middle tibiae covered with spines; hind tibiae with only a few small spines between the bases of the largest spines.

Male genitalia, as in Plate XVII, fig. 10b. *Ovipositor*, long, pubescent.

Type ♂, from Mullewa, Western Australia (coll. C. May), in the collection of the South Australian Museum.

Tartessella incompleta, sp. nov.

(Plate XVII, fig. 12)

Length, 9 mm. *Head*, width 2·5 mm., pale yellow with yellow markings on the frons, the vertex mottled with brown; eyes, brown mottled with black. *Pronotum*, grey mottled with brown; lateral angles behind the eyes, pale yellow marked with an irregular brown pattern. *Scutellum*, pale yellow with two dark brown lateral longitudinal markings. *Tegmen*, hyaline, colourless; veins with several incomplete cross-veins, especially on the anal area. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown. *Legs*, hind tibiae with the basal spurs of one row of spines large and pointed, the intervening spines few and small.

Male genitalia, aedeagus as in Plate XVII, fig. 12; sub-genital plates, parameres and pygophores similar to those of the genotype.

Type ♂, from Cannamilla, Queensland (coll. H. Hardcastle), in the collection of the South Australian Museum.

Tartessella campbelli, sp. nov.

(Plate XVII, fig. 11)

Length, 8 mm. *Head*, width 2·6 mm.; ventral surface whitish with transverse orange markings on the frons; vertex mottled with pale brown; eyes, grey. *Pronotum* and *scutellum*, grey mottled with apricot yellow. *Tegmen*, whitish-hyaline, veins brown. *Thorax* and *abdomen*, ventral surface, pale brownish-yellow. *Legs*, pale yellow; hind tibiae with long hair-like spines between the bases of the row of the largest spines.

Type ♂, from Newcastle Water, North Australia (coll. T. G. Campbell), in the collection of the C.S.I.R. Division of Entomology at Canberra, F.C.T.

Tribe THYMBRINI

Eight genera are included in this tribe. Two of these are new. Kirkaldy's genus *Alseis* (1907) cannot be identified from his description, but is probably closely related to other genera in the Thymbrini. *Epipsychidion* Kirk. (1906, 1907) also doubtless belongs here.

A figure of the head of the genotype of the latter genus is given (Plate XVIII, fig. 9). This was drawn from the paratype, which unfortunately is no longer available for study, hence neither this genus nor *Alseis* are included in the following key:

KEY TO THE GENERA OF THE THYMBRINI

1. Head angularly produced anteriorly, arrow-shaped; ocelli marginal or on the dorsal surface of the head	2
Head not angularly produced; ocelli not visible dorsally	3
2. Eyes, in dorsal aspect, in alinement with the margin of the head; general coloration, pale green	*Hackeriana* gen. nov. Genotype, *Hackeriana huonensis*, sp. nov.
Eyes slightly protuberant, not in alinement with the margin of the head; general coloration, brown	*Rhotidus* Walker Genotype, *Rhotidus cuneatus* Walk.
3. Pronotum steeply declivous; crown of head in dorsal aspect, visible medianly as a very narrow border	*Macroceps* Signoret. Genotype, *Macroceps fasciatus* Sign.
Pronotum not steeply declivous; crown of head visible widely between the eyes	4
4. Pronotum flattened, not evenly convex, the anterior third flat and on a level with the crown of the head	*Putoniessa* Kirkaldy Genotype, *Putoniessa nigra* (Walk.)
Pronotum evenly convex, the anterior third not on a level with the crown of the head	5
5. Crown of head from above, wider in the middle than against the eyes	*Thymbris* Kircaldy Genotype, *Thymbris inachis* Kirk.
Crown of head from above, narrower in the middle than against the eyes, or of even width	*Rhotidoides*, gen. nov. Genotype, *Rhotidoides norfolkensis*, sp. nov.

Genus **Thymbris** Kirkaldy

Bull. Hawaii Sug. Ass. Ent. 3; 49, 1907

Head from below, lorae long and wide, the clypeus narrowing anteriorly and extending well beyond the edge of the maxillary plates. The head is flat and not declivous at its anterior margin. The lateral sutures of the frons are straight, but not parallel to each other up to the antennal ledges, thence they are rounded. The antennal pits are shallow, and the antennal ledges strong, extending almost as far as the eyes on each side. Posterior apex of head arrow-shaped, the apex of the frons pointed and convex. The anterior portion of the frons up to the antennal ledges is flat. The ocelli, which are large, are situated in very shallow depressions on the vertical portion of the vertex, and are nearer to the eyes on each side than to each other.

Head from below, crown widest in the centre, where it is slightly produced anteriorly, and is narrowest at a point half-way between the apex and the eyes. The pronotum is considerably longer than the scutellum, and the propleurae separate the eyes from the bases of the tegmina. Tegmina long, narrowing apically. Ovipositor in female extending to just beyond the apices of the folded tegmina. Male genitalia with long sub-genital plates, short parameres, and pygophores with small distinct processes.

Four described species belong to this genus: *Bythoscopus punctivena* Walker (1858a); *Thymbris inachis* Kirk. and *Thymbris iphianassa* Kirk. (1907); and *Rhotidus aequalis* Dist. (1907). It would appear from the description that *aequalis* Dist. is synonymous with *inachis* Kirk. One new species is described below, and a figure is given of the head of the genotype *Thymbris inachis* Kirk. (Plate XVIII, fig. 8). This genus appears to be confined to the more tropical regions of the continent.

Thymbris melvillinsis, sp. nov.

(Plate XVIII, fig. 7)

Length, 12 mm. *Head,* ventral surface with the anterior two-thirds yellowish-brown with small dark brown markings; posteriorly two or three transverse black bands, one of which is situated on the ventral portion of the vertex, the other or others on the crown or dorsal portion of the vertex. The ocelli are situated on the middle band. *Pronotum* and *scutellum,* pale yellowish-brown regularly mottled with dark brown. *Tegmen,* veins wide. whitish-yellow; tegmen bordering the veins dull brown, elsewhere yellowish-hyaline. *Thorax* and *abdomen,* ventral surface, brown.

Male genitalia, as in Plate XVIII, fig. 7.

Type ♂, from Melville Island (coll. W. D. Dodd), in the collection of the South Australian Museum.

Rhotidoides, gen. nov.

Head from below, anterior margin declivous, lorae wide, and the labium reaching to between the middle pair of legs. The frons, which may be somewhat raised above the lorae and clypeus, is slightly convex, and the lateral sutures are curved. The antennal ledges, which are straight, form an obtuse angle with the lateral frontal sutures. The hind margin of the frons is distinct and rounded, and forms part of a transverse ridge that extends to the eyes on either side. The ocelli are either ventrally placed or on the vertical portion of the vertex, slightly closer to the eyes on each side than to each other, and lying above the transverse ridge. The latter is parallel to the hind margin of the head but not to the antennal ledges. The head in profile is evenly rounded, and from above the

crown is wide. The pronotum, which is only slightly longer than the scutellum, is slightly convex. Hind tibiae without any small spines set between the bases of the prominent spines. Male genitalia with the sub-genital plates long, wider apically than at the base, and the parameres hook-shaped. The pygophores are narrow and produced apically, but with no separate thickened processes.

This genus contains two species, both of which are extremely variable in coloration and in the shape of the head. It is probably closely related to *Rhotidus* Walk.

Rhotidoides norfolkensis, sp. nov. (Genotype)

(Plate XVIII, figs. 5a-5e)

Length, 9·6 mm. *Head*, width 3 mm., ventral surface pale yellowish-brown mottled with reddish-brown, slightly darker in colour above the transverse ridge; frons anteriorly on the same plane as the clypeus, the anterior margin of the head only slightly recurved. Dorsal surface, crown variable in shape, either slightly produced so that it is wider in the middle than against the eyes, or evenly rounded and narrower in the middle than against the eyes. *Pronotum*, declivous, brown mottled with white. *Tegmen*, hyaline-brown, with indistinct whitish markings; veins brown with white bars. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown. *Legs*, pale yellowish-brown, but for the apices of the prominent spurs on the hind tibiae, which are black. *Ovipositor*, extending slightly beyond the apices of the folded tegmina.

Male genitalia, with the pygophores narrowing apically, but not greatly produced.

Type ♂, from New Norfolk, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Note.—This species, which has been taken at Sydney as well as in several other localities in Australia, is variable both in shape and in coloration, and in the shape of the posterior margin of the head in dorsal aspect. Specimens may be pale reddish-brown or dark chocolate brown, and differ in the amount of white markings present.

Rhotidoides montana, sp. nov.

(Plate XVIII, figs. 6a-6c)

Length, 6 mm., 7 mm. *Head*, width 2 mm., ventral surface pale or dark brown with or without yellowish mottlings. There is usually a broad, pale, brownish-yellow transverse stripe across the posterior third of the frons extending to the eyes on each side. Anteriorly the frons is slightly swollen, and the anterior margin of the head is slightly recurved; posteriorly the head is evenly rounded, not

produced, the ocelli lying in shallow depressions. Crown of head in dorsal aspect, of equal width throughout, or wider against the eyes than in the middle. *Pronotum* and *scutellum*, light or dark brown mottled with grey. *Tegman*, hyaline or hyaline-brown with or without whitish mottlings. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown. *Legs*, pale yellowish-brown, but for the bases of all the spines on the hind tibiae, which are black. *Ovipositor*, not extending beyond the apices of the folded tegmina.

Male genitalia with the pygophores narrowly produced posteriorly.

Type ♂, from Mount Wellington, Tasmania, in the collection of the Australian Museum, Sydney.

Note.—This is another very variable species, both in coloration and in the shape of the crown of the head. Although this species has been taken at sea-level in Southern Tasmania, it appears to be largely a mountain form, having been collected at Leura, in the Blue Mountains, Mount Kosciuscko, Canberra, and on the Bogong Plains, Victoria.

Genus **Rhotidus** Walker

Journ. Ent. I; 318, 1862

Rhothidus Stal, Öfv. Vet.-Ak. Förh. 22; 157, 1865

This genus is closely related to *Thymbris* Kirk., differing principally in the produced arrow-shaped head, dorsal position of the ocelli, and in the structure of the male genitalia.

Head from below, the antennal pits are shallow and the frons widens considerably posteriorly, the hind margin terminating at the apex of the head. The frons is flat anteriorly; posteriorly it is raised into a longitudinal ridge. From the posterior margin of the frons to the eyes on each side is a ridge which separates the dorsal from the ventral surface of the head. The ocelli are on the dorsal surface of the head, either close to or well away from the anterior margin. The pronotum in most species is steeply declivous and much longer than the scutellum. The propleurae narrowly separate the eyes from the bases of the tegmina. The tegmina narrow posteriorly. The hind tibiae have minute hair-like spines, not set on distinct bases, between the basal spurs of the largest spines. The ovipositor extends well beyond the folded tegmina, and the male genitalia have pygophores without any processes, and parallel-sided subgenital plates.

Eight described species can be placed in this genus: *Rhotidus cuneatus* Walk. (1862) (Genotype); *Rhotidus stali* Kirk. (Stål 1865, Kirk. 1907); *R. convivus* Stal; *R. leucostictus* Stål; *R. breviceps* Stal (1865); *Ledra teliformis* Walk.; *L. cuspidata* Walk.; *L. navicula* Walk. (Walk., 1851, a, b; Dist., 1907).

The seven species described by Kirkaldy (1906), and placed in the this genus, do not belong to the Euscelidae, but to the Ledridae. Four new species are described below. Species in this genus differ from each other in the relative length of the head, position of the ocelli, and shape of the ventral surface of the head.

Rhotidus leurensis, sp. nov.

(Plate XIX, figs. 1a, 1b)

Length ♀, 16 mm. *Head,* width 3·8 mm., ventral surface pale brown, not recurved anteriorly; frons almost flat anteriorly; posteriorly, to the antennal ledges it is raised medianly into a longitudinal ridge bordered by shallow troughs; antennal pits shallow. Dorsal surface dark brown, arrow-shaped, rounded apically; greater in length than the scutellum, laterally emarginate; distance from the ocelli to the apex of the head greater than the distance between the ocelli and the eyes on each side. *Pronotum,* dark brown, not steeply declivous. *Tegmen,* hyaline-brown with indistinct whitish maculations. *Thorax* and *abdomen,* ventral surface, and *legs,* pale brown.

Type ♀, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Rhotidus insularis, sp. nov.

(Plate XIX, fig. 4)

Length (♀), 12·5 mm. *Head,* width 3 mm., ventral surface pale brownish-yellow mottled with brown, slightly recurved anteriorly; frons evenly convex anteriorly, and with a median longitudinal ridge posteriorly. Dorsal surface marked with a pattern of light and dark brown, shorter than the scutellum; distance between the ocelli and the apex of the head only slightly greater than between the ocelli and the eyes on each side; medianly a longitudinal ridge, laterally straight, not emarginate. *Pronotum,* brown mottled with white. *Scutellum,* brown. *Tegmen,* hyaline-brown mottled with white, the white markings slightly raised and blister-like. *Thorax* and *abdomen,* ventral surface, and *legs,* pale brownish-yellow.

Type ♀, from Launceston, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Rhotidus wilsoni, sp. nov.

(Plate XIX, fig. 2)

Length (♀), 14 mm. *Head,* width 3·5 mm., ventral surface pale brownish-yellow, slightly recurved anteriorly; frons with a median longitudinal ridge posteriorly. Dorsal surface, khaki-coloured mottled with pale buff, with a median longitudinal ridge; ocelli a little closer to the eyes on each side than to the apex of the head; sides of the

head straight, apex rounded. *Pronotum,* concolorous with the head, declivous. *Scutellum,* concolorous with the pronotum, but for the anterior lateral angles, which are brown. *Tegmen,* pale ochreous-brown mottled with white markings, of which the largest and most distinct occur on the veins. *Thorax* and *abdomen,* ventral surface, and *legs,* pale brownish-yellow.

Type ♀, from Millgrove, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Rhotidus kiatensis, sp. nov.

(Plate XIX, figs. 3a, 3b)

Length (♂), 12 mm. *Head,* width 3·8 mm., ventral surface pale yellowish-brown mottled with dark brown and black; antennal pits deep, antennal ledges distinct; frons flat anteriorly, posteriorly a wide median longitudinal ridge with deep depressions on either side. Dorsal surface declivous, apricot-yellow mottled with black. There is no distinct division between the dorsal and ventral surfaces of the head as with other species, so that the antennal ledges against the eyes are almost on the same plane as those parts of the posterior margin of the crown that lie immediately behind them. *Pronotum,* steeply declivous, black mottled with yellow, propleurae wide. *Scutellum,* concolorous with the pronotum. *Tegmen,* dark hyaline-brown mottled with grey or white. *Thorax* and *abdomen,* ventral surface, pale brown. *Legs,* pale brown with dark brown and black markings.

Type ♂, from Kiata, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Genus **Putoniessa** Kirkaldy

Bull. Hawaii Sug. Ass. Ent. 3; 50, 1907

Head ventrally wide, more or less flat, excepting anteriorly, where the anterior two-thirds of the clypeus and the anterior margin of the lorae are recurved. The antennal pits are shallow. The hind margin of the frons is distinct, straight or slightly rounded; from the hind border to the eyes on each side is an indistinct ridge, not parallel to the antennal ledges. The ocelli are ventrally placed, not touching the frons, and lying postero-laterally to the hind margin of the frons. The pronotum is more or less flat, transversely striated, and almost twice the length of the scutellum. The tegmina are long and narrow apically, and the appendices are very narrow and do not reach to the apices of the tegmina. The hind tibiae are strongly spinose, and lack minute spines between the largest spines (those set on enlarged bases), but a row of long spines that arise direct from the tibiae

have small spines set between them at the distal end. Male genitalia with broad sub-genital plates, wrench-shaped parameres, and pygophores with thickened apical processes.

Five described species belong to this genus: *Gypona nigra* Walk. (1862), *Bythoscopus rivularis* Walk., *B. dorsalis* Walk. (1851), *B. repletus* Walk. (1858a); and *Putoniessa dignissima* Kirk. (1907). *P. dignissima* is a synonym of *nigra* Walk., and *repletus* and *dorsalis* are synonymous with *rivularis*. Two news species are described below, and a redescription given of the genotype *Putoniessa nigra* Walk. and of *Putoniessa rivularis*.

Putoniessa nigra (Walker)

(Plate XVIII, figs. 1a-1c)

Gypona nigra Walk. *Jour. Ent.* 1; 319, 1862
Putoniessa dignissima Kirk. *Bull. Hawaii Sug. Ass. Ent.* 3; 50, 1907

Length, 8-10 mm. *Head*, rugose, black with pale brown or yellowish maculations. Ventral surface nearly as long as wide; frons with a median depression close to the hind border, ocelli well away from the hind margin of the frons. Edges of the head, separating the crown from the ventral surface of the head, sharp and well-defined. Crown of head, slightly wider against the eyes than in the middle. *Pronotum*, concolorous with the head, with a narrow depressed border lying against the crown, not extending as far as the eyes on each side; the remainder convex and transversely striated. *Tegmen*, black or dark brown with irregularly-shaped white and hyaline areas, ranging in size from small spots to extensive markings. *Thorax* and *abdomen*, ventral surface, and *legs*, black with pale brown markings.

Male genitalia, as in Plate XVIII, fig. 1c.

Distribution: Queensland and New South Wales.

Putoniessa rivularis (Walker)

(Plate XVIII, fig. 4)

Bythoscopus rivularis Walk. *List Homoptera* III; 865, 1851
Bythoscopus dorsalis Walker, *List Homoptera* III; 867, 1851
Bythoscopus repletus Walker, *Supplement* 267, 1858

Length, 8-10 mm. *Head*, chestnut-brown with pale brown and black markings; ventrally much wider than long, the frons with a slight median depression close to the posterior border, ocelli close to the hind margin of the frons; apical margin of head evenly rounded. Crown from above much wider against the eyes than in the middle. *Pronotum*, pale brown with dark brown markings, almost flat, the anterior border being only at a slightly lower level than the rest of the pronotum. *Tegmen*, mottled with an irregular pattern of brown

and white, the white areas opaque or hyaline. *Thorax* and *abdomen*, ventral surface, and *legs*, marked with a variable pattern of light and dark brown.

Male genitalia, as in Plate XVIII, fig. 4.

Distribution: New South Wales, Victoria, South Australia, and Tasmania.

Putoniessa maculata, sp. nov.

(Plate XVIII, figs. 3a, 3b)

Length, 8 mm. *Head* marked with an irregular pattern of pale brownish-yellow and black, ventrally much wider than long; lateral frontal sutures above the antennal ledges parallel to each other, and the ridge separating the frons from the vertex almost straight. Ocelli close to the hind margin of the frons on the vertical portion of the vertex. Crown evenly rounded, not separated from the ventral portion of the vertex by a sharp edge, slightly wider against the eyes than in the middle. *Pronotum*, concolorous with the head, and, excepting for the flat border behind the head, transversely striated. *Tegmen*, black or dark brown with irregular hyaline and white areas, of which the smaller are more or loss circular or oval in outline; veins distinct, pale brown. *Thorax* and *abdomen*, ventral surface, and *legs*, black and dark brown with pale brownish-yellow markings.

Male genitalia, as in Plate XVIII, fig. 3b.

Type ♂, from Seven-Mile Beach, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Note.—This species, which in coloration resembles *P. nigra* and in structure *P. rivularis*, was found in large numbers under the bark of Eucalyptus trees.

Putoniessa galliensis, sp. nov.

(Plate XVIII, fig. 2)

Length, 7 mm. *Head*, pale brown with black and whitish markings, nearly as long as wide. Anterior border of head not so steeply declivous as in other species in the genus, ocelli on vertical part of vertex; vertex evenly rounded. Dorsal surface, medianly produced, so that the crown is slightly wider in the middle than against the eyes. *Pronotum*, heart-shaped, almost flat, grey with irregular black and brown markings. *Tegmen*, hyaline and white, marked with a pattern of light and dark brown; the pattern, which has a longitudinal axis, may continue on to the pronotum. *Thorax* and *abdomen*, ventral surface, and *legs* brown.

Type ♀, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Genus **Macroceps** *Signoret*

Ann. Soc. Ent. Fr. 5 (X) ; 364, 1880

The labium reaches to between the middle pair of legs, and the lorae are swollen. The anterior border of the head, up to and including the anterior third of the frons, is at right angles to the posterior border of the head. The frons is swollen anteriorly and flat posteriorly; the hind margin is distinct, and may be straight or slightly rounded. An indistinct ridge extends from the hind border of the frons to the eyes on each side, and is more or less parallel to the antennal ledges. The vertex is vertical; the ocelli are thus neither dorsal nor ventral in position, and are close to, but not touching, the posterior border of the frons. The pronotum is steeply declivous, so that of the head, from above, only the eyes and a very narrow border of the crown are visible. The tegmina do not narrow posteriorly, and the last ventral abdominal segment in the female is not divided.

Note.—Insects in this genus superficially resemble *Ipo* spp. Only one previously described species belongs to this genus; two new species are described below. Unfortunately, as no males are available, the structure of the male genitalia cannot be figured for comparison with those of species in other genera dealt with.

Macroceps fasciatus Signoret

(Plate XIX, figs. 8a-8c)

Macroceps fasciatus Sign. *Ann. Soc. Ent. Fr.* 5 (X) ; 364, 1880

The redescription given below was made from a single specimen, collected at Kangerilla, South Australia.

Length, 5 mm. *Head*, width 2·5 mm., anterior half pale brown mottled with dark brown; posterior half chestnut-brown; ocelli red, eyes brown. *Pronotum*, chestnut-brown, with an indistinct median longitudinal black stripe. *Scutellum*, chestnut-brown. *Tegmen*, hyaline-brown; apically pale brown; proximally a white oblique fascia extends from the anal angle to the costal border. *Thorax*, ventral surface, pale brown. *Legs*, yellowish-brown with brown markings. *Abdomen*, ventral surface, pale yellowish-brown.

Macroceps tonnoiri, sp. nov.

(Plate XIX, fig. 10)

Length, 7 mm. *Head*, width 3 mm., the anterior half dark brown mottled with yellow, the posterior half grey mottled with brown and black. *Pronotum*, light brown mottled with dark brown, and with a broad median longitudinal black stripe. *Scutellum*, chestnut-brown. *Tegmen*, opaque or hyaline with white, brown, and black markings;

the white markings may form a fascia across the tegmen or be absent; veins with black bars. *Thorax*, ventral surface marked with a pattern of light and dark brown. *Legs*, front two pairs black, the proximal halves of the front femora pale brown and the distal halves black; hind tibiae and tarsi light brown, but for the apices and bases of the spines, which are black. *Abdomen*, ventral surface light brown, genital segments dark brown.

Type ♀, from Mount Kosciuscko, New South Wales (coll. A. L. Tonnoir), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Note.—This species has also been taken at Hobart, Tasmania.

Macroceps tamarensis, sp. nov.

(Plate XIX, figs. 9a-9c)

Length, 6·5 mm. *Head*, width 2·8 mm., pale brown, ocelli red, eyes greyish-brown; frons less convex anteriorly than with *M. tonnoiri*, and the lorae more declivous. *Pronotum* and *scutellum*, pale chestnut-brown mottled with yellowish-brown. *Tegmen*, hyaline, suffused with pale brown; veins barred with brown and white. *Thorax*, ventral surface, and front two pairs of legs brown, hind tibiae pale brown, but for the apices of the tibiae and the bases of the spines, which are dark brown. *Abdomen*, ventral surface brown.

Type ♀, from Launceston, Tasmania, in the collection of the South Australian Museum.

Hackeriana, gen. nov.

This genus comprises species which superficially resemble *Rubria* spp. (Ledridae) in coloration and shape. The structure of the male genitalia suggests relationship with *Putonicssa*, whilst the fact that the head is similarly shaped to those of *Rhotidus* is of little significance. All known species in this genus are pale green, thus differing from other species described in this paper, which are largely brown or black.

Head from below, slightly transversely convex, the apex of the clypeus slightly depressed and the lorae wide. The antennal pits are shallow and the antennal ledges indistinct. The apical margin of the head is arrow-shaped, and the ocelli marginal or just on the dorsal surface of the head. The eyes are not prominent, and the crown is much wider in the middle than against the eyes. The propleurae narrowly separate the eyes from the bases of the tegmina. In the female the abdomen extends beyond the apices of the folded tegmina. The male genitalia consist of wide parallel-sided subgenital plates and short parameres. The pygophores have large thickened processes, but are not produced posteriorly.

Hackeriana huonensis, sp. nov. (Genotype)

(Plate XIX, figs. 6a, 6b)

Length, 7 mm. General coloration, yellowish-green. *Head*, width 2·5 mm., eyes reddish-brown. A transverse white line on the apical margin of the head separates the ventral from the dorsal surface. Crown flat, ocelli pale red, slightly nearer to the eyes than to the apex of the head. Apex of head rounded, not acute. *Tegmen*, hyaline, costal margin anteriorly green; veins pale green.

Type ♂, from Huonville, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Hackeriana glauca, sp. nov.

(Plate XIX, fig. 7)

Length, 7·5 mm. General coloration, pale greenish-yellow. *Head*, width 2·5 mm.; eyes brownish-red. The white line on the apical margin of the head is bordered narrowly on each side with brown. Crown with a shallow median longitudinal depression; ocelli nearer to the eyes on each side than to the apex of the head. *Tegmen*, pale yellowish-hyaline, veins pale green.

Type ♂, from Adelaide, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Hackeriana rotundata, sp. nov.

(Plate XIX, fig. 5)

Length, 8·2 mm. General coloration, pale greenish-yellow. *Head*, width 2·5 mm., more swollen apically, less flattened, and more elongate than with the preceding species. Apically a white stripe bordered with brown; ocelli much closer to the eyes on each side than to the apex of the head. *Pronotum*, more convex than with the preceding species. *Tegmen*, hyaline, veins green.

Type ♀, from Vivonne Bay, Kangaroo Island, in the collection of the South Australian Museum.

Discussion

The relationship of the genera described in this paper to genera in other Jassoid families is somewhat obscure. *Rhotidus* spp. have in the past been linked up with the Ledridae because their ocelli are dorsally placed. Several species of *Tartessus* described by Walker were placed in the genus *Bythoscopus* because their ocelli are more

or less ventral in position, and Kirkaldy considered that *Putoniessa dignissima* formed a link between the Jassidae and Bythoscopidae, and pointed the way to the Stenocotidae.

Relationships between genera cannot be decided by the position of the ocelli alone. Whilst it is probable that the primitive position of the ocelli amongst Jassoid insects was a ventral one, some primitive families, as, for instance, the Ulopidae, have the ocelli dorsally placed. A tendency is evident in many genera for the ocelli to move from a ventral position to a marginal, and finally a dorsal, one. This change-over may frequently be correlated with a progressive elongation of the head. The venation of the tegmen throughout the whole family is remarkably similar, and although venational characters are thus seldom a guide to relationships, they do serve to separate the Tartessusini from the Thymbrini. The continuation of the ambient vein of the wing on to the claval area, as occurs in all three genera of the Tartessusini, is an unusual feature. The shape and armature of the hind tibiae, especially of *Macroceps* spp., suggest relationships with the Eurymelidae. However, the male genitalia of other genera discount such a relationship, since their structure, especially as regards the large pygophore and pygophore process, is in no way Eurymeloid.

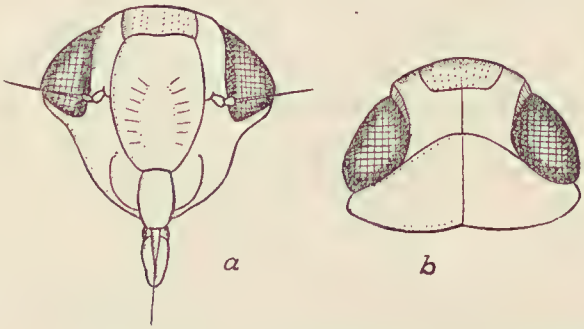
As with the Eurymelidae and Bythoscopidae, an apparent intrinsic difference in specific differentiation is evident in the various genera. Some genera *(Tartessus)* have numerous well-defined species, a few of which are widely distributed, and others apparently localised. Some genera *(Rhotidus)* have a large number of well-defined species, none of which have a wide distribution, specific differentiation having rapidly followed geographical isolation. With other genera *(Rhotidoides)* geographical isolation has resulted in a large number of colour varieties, and even in varieties that have minor structural differences, but has given rise to no new fixed species.

As with other papers in this series, I am indebted to Mr. W. E. China, of the British Museum, for considerable assistance and encouragement.

Appendix

In both this and earlier papers of a similar nature, in descriptions concerned with head structures, the large median plate bearing transverse muscle impressions has been referred to as the 'frons,' and the small rectangular plate that lies directly in front of the frons as the 'clypeus,'. In a recent publication Snodgrass (1935) brings evidence to show that this terminology does not represent the true homologies of the plates in question. He considers that the large plate, from which the dilator muscles of the sucking-pump arise, belongs to the clypeal region. This is because in his opinion the

sucking-pump is part of the mouth cavity and not part of the pharynx. Whilst not disputing Snodgrass's interpretation in so far as it concerns the cicada, where a median ocellus occurs on a small triangular plate immediately behind the large swollen plate, it would appear from the available evidence that with the jassoids and cercopids, where there is no median ocellus, Snodgrass's postclypeus and the frons of the present author is in reality the fronto-clypeus.



Text-fig. 1.—*a*. Head of a nymph of *Tartessus* sp., ventral aspect. *b*. Head of a nymph of *Tartessus* sp., dorsal aspect.

Text-figures 1a and 1b represent the head of a nymph of *Tartessus* sp. in ventral and dorsal aspect. In the nymphs of leaf-hoppers in this genus a distinct rectangular plate occurs behind the sclerite that bears the muscle impressions. This plate is doubtless the frons. In adult *Tartessus* spp. the two plates are fused (Plate XVII, fig. 1a).

Further evidence that the large median sclerite comprises both part of the clypeus and part of the frons in jassoids, is supplied by a study of nymphs of species belonging to many genera. In these a Y-shaped suture occurs above the large median sclerite, the arms of the Y lying on each side of its posterior margin. This suture is doubtless the epicranial suture, the divergent arms of which mark the boundary between frons and vertex.

In some cercopids the frons is also not a distinct sclerite, though in some species, as, for instance, *Petyllis australiensis* Kirk., it may be seen as a small rectangular plate on the crown of the head. In the nymphs of many cercopids, for example, *Bathylus albicincta* Erichs., a small triangular plate, bounded laterally by distinct sutures, occurs posterior to the large swollen postclypeus. The two plates are separated from each other by a shallow groove. In the adults the groove is not apparent, the two plates appearing as one.

Since the terms 'anteclypeus' and 'frontoclypeus' are somewhat unwieldy, it is not proposed to employ them in purely taxonomic works, and a continued use will be made of the words 'clypeus' and 'frons' respectively.

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Plate XVII

Fig. 1a.—*Tartessus fulvus*, head, ventral aspect.
Fig. 1b.—*Tartessus fulvus*, tegmen.
Fig. 1c.—*Tartessus fulvus*, wing.
Fig. 1d.—*Tartessus fulvus*, hind tibia.
Fig. 1e.—*Tartessus fulvus*, male genitalia.
Fig. 2.—*Tartessus io*, aedeagus.
Fig. 3.—*Tartessus idyia*, aedeagus.
Fig. 4a.—*Tartessus mackerrasi*, head and thorax, dorsal aspect.
Fig. 4b.—*Tartessus mackerrasi*, aedeagus.
Fig. 5a.—*Tartessus obscurus*, head and thorax, dorsal aspect.
Fig. 5b.—*Tartessus obscurus*, aedeagus.
Fig. 6.—*Tartessus blundellensis*, head and thorax, dorsal aspect.
Fig. 7.—*Tartessus pallidus*, head and thorax, dorsal aspect.
Fig. 8.—*Tartessus spinosus*, aedeagus.
Fig. 9a.—*Tartessoides griseus*, tegmen.
Fig. 9b.—*Tartessoides griseus*, head, ventral aspect.
Fig. 9c.—*Tartessoides griseus*, head and thorax, dorsal aspect.
Fig. 10a.—*Tartessella attenuata*.
Fig. 10b.—*Tartessella attenuata*, male genitalia.
Fig. 10c.—*Tartessella attenuata*, head, ventral aspect.
Fig. 11.—*Tartessella campbelli*, head and pronotum, dorsal aspect.
Fig. 12.—*Tartessella incompleta*, aedeagus.

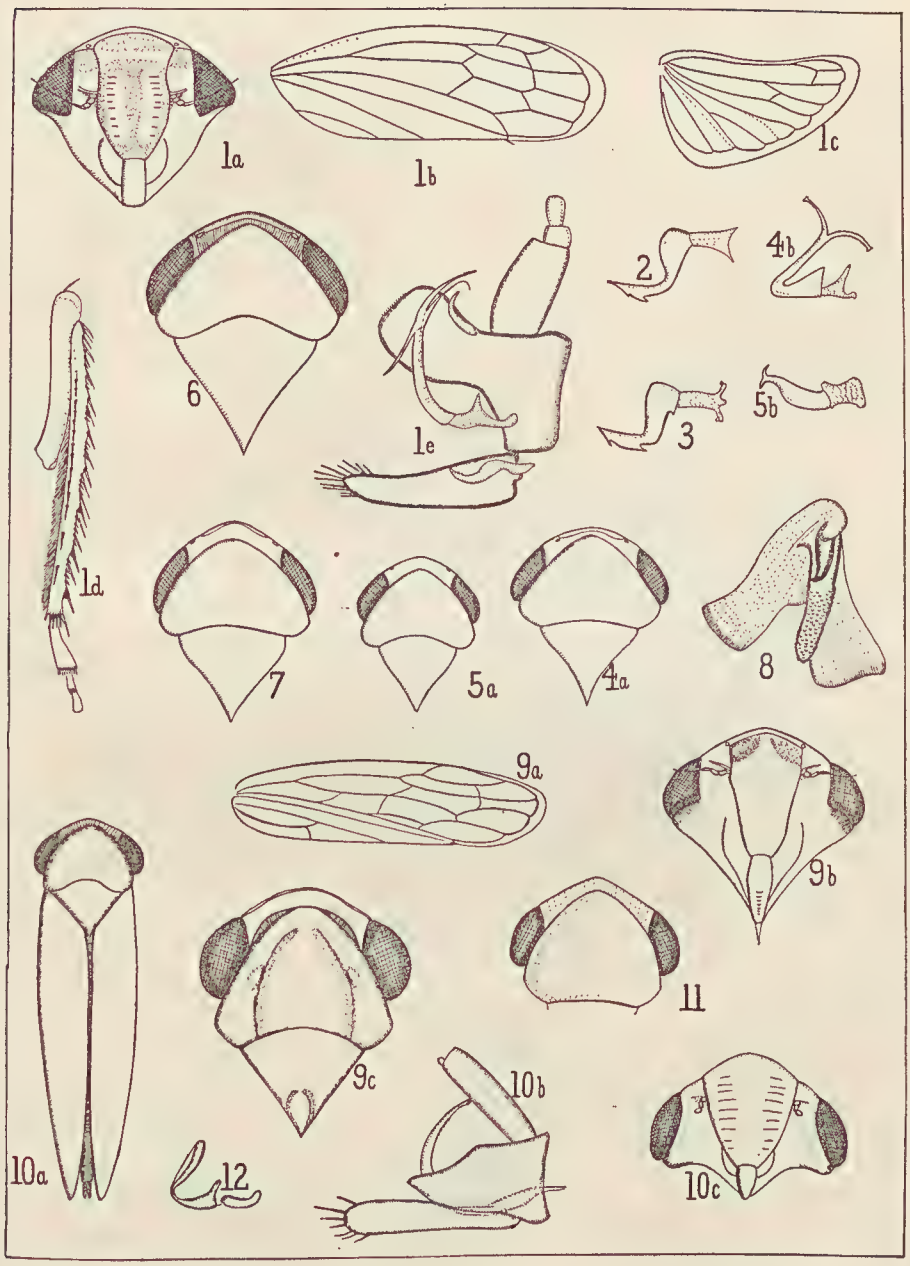
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Plate XVIII

Fig. 1a.—*Putoniessa nigra*, hind tibia.
Fig. 1b.—*Putoniessa nigra*, head, ventral aspect.
Fig. 1c.—*Putoniessa nigra*, male genitalia.
Fig. 2.—*Putoniessa galliensis*, head and thorax, dorsal aspect.
Fig. 3a.—*Putoniessa maculata*, head and thorax, in profile.
Fig. 3b.—*Putoniessa maculata*, male genitalia.
Fig. 4.—*Putoniessa rivularis*, aedeagus.
Fig. 5a.—*Rhotidoides norfolkensis*, head and thorax, dorsal aspect.
Fig. 5b.—*Rhotidoides norfolkensis*, male genitalia.
Fig. 5c.—*Rhotidoides norfolkensis*, tegmen.
Fig. 5d.—*Rhotidoides norfolkensis*, wing.
Fig. 5e.—*Rhotidoides norfolkensis*, head, ventral aspect.
Fig. 6a.—*Rhotidoides montana*, male genitalia.
Fig. 6b.—*Rhotidoides montana*, head and thorax, in profile.
Fig. 6c.—*Rhotidoides montana*, head and thorax, dorsal aspect.
Fig. 7.—*Thymbris melvillensis*, male genitalia.
Fig. 8.—*Thymbris inachis*, head and thorax, in profile.
Fig. 9.—*Epipychidion epipyropis*, head, ventral aspect.

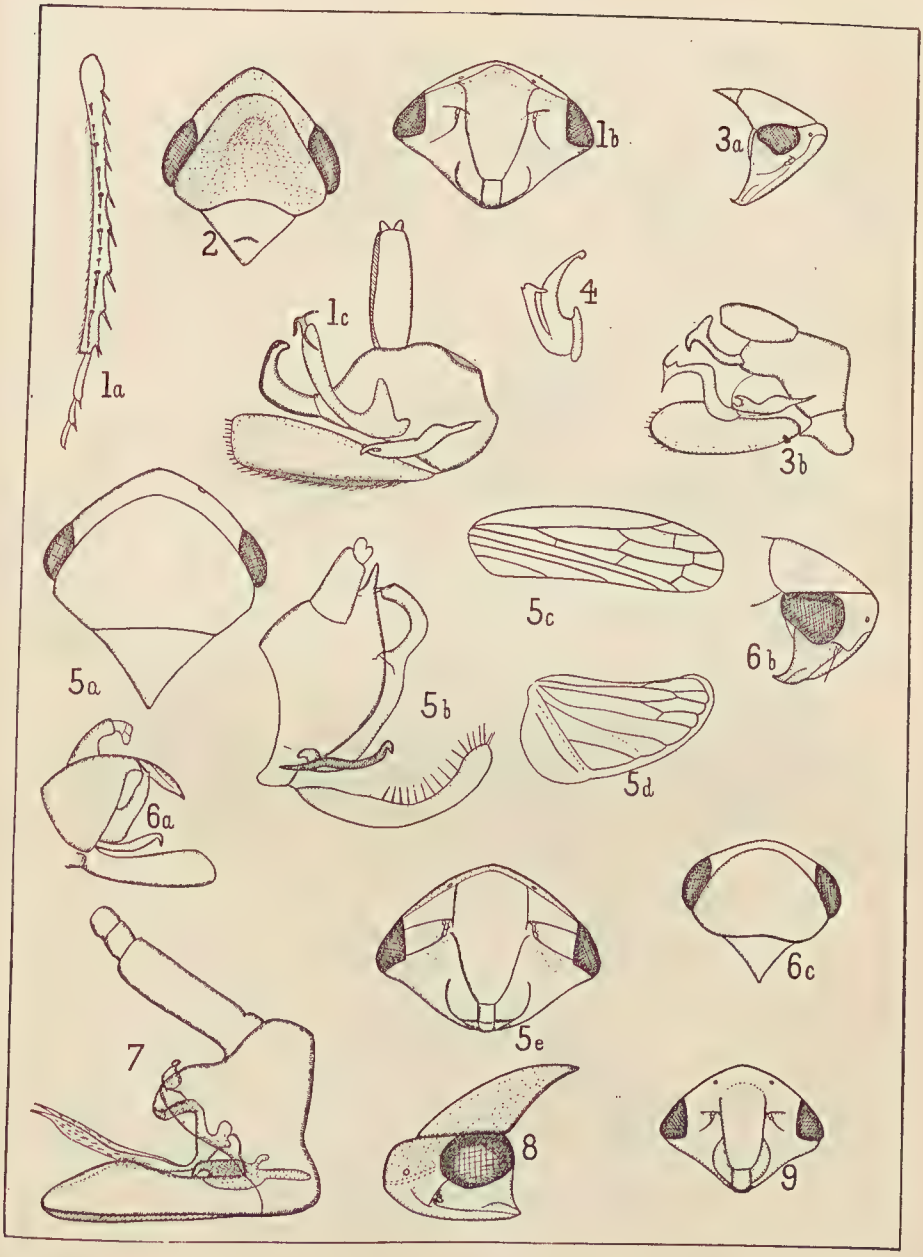
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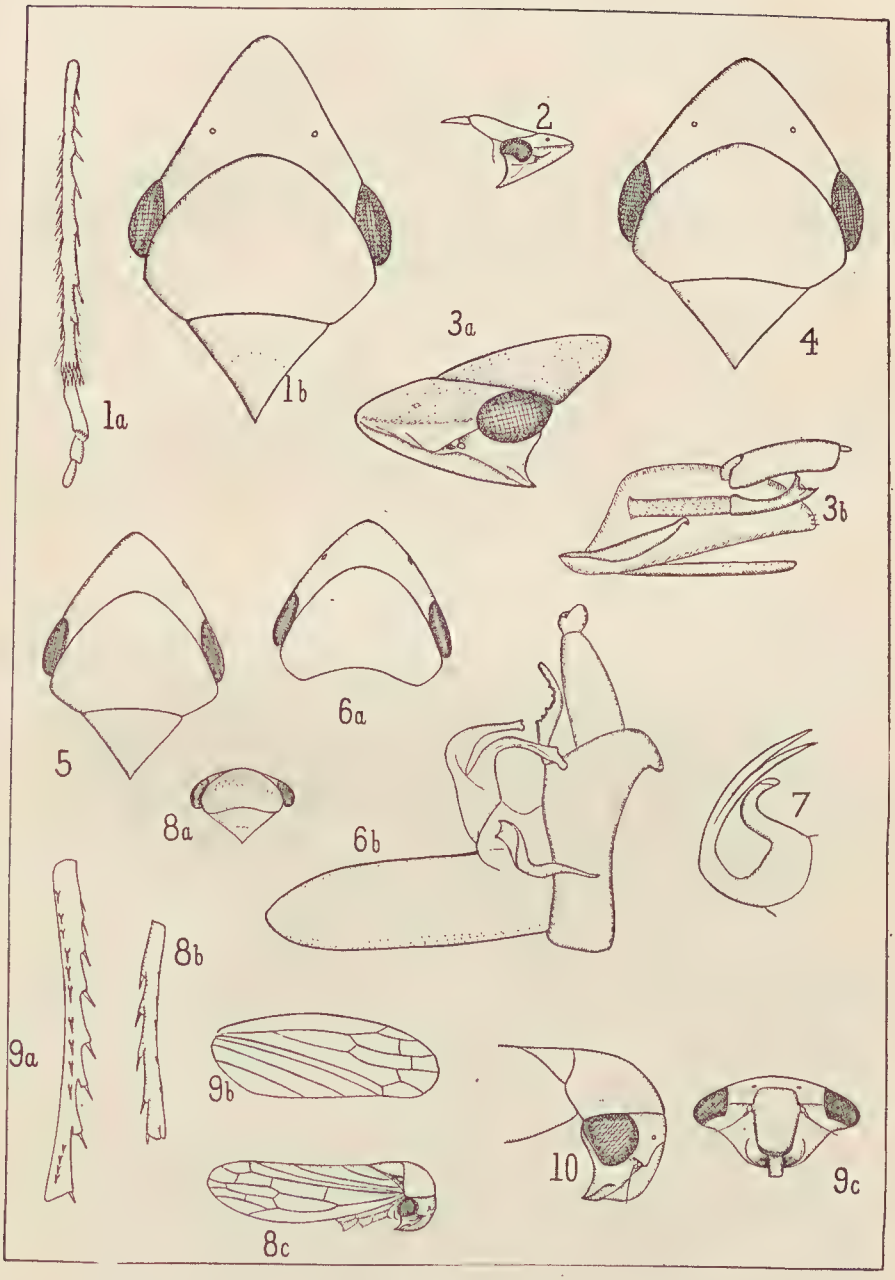
Plate XIX

Fig. 1a.—*Rhotidus leurensis*, hind tibia.
Fig. 1b.—*Rhotidus leurensis*, head and thorax, dorsal aspect.
Fig. 2.—*Rhotidus wilsoni*, head and thorax, in profile.
Fig. 3a.—*Rhotidus kiatensis*, head and thorax, in profile.
Fig. 3b.—*Rhotidus kiatensis*, male genitalia.
Fig. 4.—*Rhotidus insularis*, head and thorax, dorsal aspect.
Fig. 5.—*Hackeriana rotundata*, head and thorax, dorsal aspect.
Fig. 6a.—*Hackeriana huonensis*, head and thorax, dorsal aspect.
Fig. 6b.—*Hackeriana huonensis*, male genitalia.
Fig. 7.—*Hackeriana glauca*, aedeagus.
Fig. 8a.—*Macroceps fasciatus*, head and thorax, dorsal aspect.
Fig. 8b.—*Macroceps fasciatus*, hind tibia.
Fig. 8c.—*Macroceps fasciatus*, in profile.
Fig. 9a.—*Macroceps tamarensis*, hind tibia.
Fig. 9b.—*Macroceps tamarensis*, tegmen.
Fig. 9c.—*Macroceps tamarensis*, head, ventral aspect.
Fig. 10.—*Macroceps tonnoiri*, head and thorax, in profile.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The Occurrence of Fossil Plants at Warrentinna, Tasmania

By

Isabel C. Cookson, D.Sc.
(Communicated by P. B. Nye, M.Sc.[1])

Plate XX

(Read 12th October, 1936)

Introduction

An outcrop in which plant-remains of early Palaeozoic type occur is situated in the railway-cutting 8 chains south of Warrentinna Railway-station, in North-Eastern Tasmania. My attention was drawn to this locality by Mr. P. B. Nye, M.Sc., whose kindly assistance with arrangements for a visit to the area I wish to acknowledge. The actual discovery there of fossil-plants is due to Mr. F. Blake, of the Geological Survey of Tasmania. Mr. Blake very generously provided me with detailed plans and directions by which I was able to find and work the fossiliferous beds more exhaustively than he had previously had time to do. The results of this work at Warrentinna,

[1] In communicating this paper Mr. Nye makes the following remarks:—

'The plant-remains referred to in this paper were discovered by Mr. F. Blake, Field Geologist, on 15th February, 1934, while engaged in a survey of the Warrentinna goldfield. The location of the discovery is a railway-cutting eight chains south of the Mara siding, on the Launceston-Herrick railway. The plant-remains are contained in fine-grained sandstones, interbedded with slates, which strike north and south and dip westerly at 66 degrees.

'Owing to the doubt as to their origin, little time was spent in the examination, and only a few specimens were collected. The specimens were brought to the notice of Dr. Cookson, and finally arrangements were made by Dr. Cookson to visit the site of the discovery. Further collections were made and examined by Dr. Cookson, and the following paper is the result.

'While the Mathinna series of slates and sandstones are referred by the Geological Survey of Tasmania to the Cambro-Ordovician System, there is no direct evidence for such, and the series might possibly belong to the Silurian System.

'This discovery is the first one in Tasmania of fossil plant-remains older than the Permo-Carboniferous period, and is therefore of considerable scientific interest.'

—*Editor, Papers & Proc.*

though unsatisfactory on account of the imperfect and fragmentary nature of the specimens obtained, are recorded here in the hope that interest may be stimulated in Tasmania which will lead to the discovery of new fossiliferous beds in the same rock series. The sedimentary rocks exposed in the railway-cuttings between Branxholm and Tarlita stations belong to the Mathinna series, and have been referred by Nye (1925) to the Cambro-Ordovician period. He says that 'no fossils have been found in this series of rocks anywhere in the north-eastern part of Tasmania, so that their age cannot be definitely determined, and they are referred to the Cambro-Ordovician system. The same belt extends southwards to the Alberton and Mathinna goldfields, and is found in other localities in the north-east of Tasmania, and is referred to as the Mathinna slates and sandstones. The similar strata of the Balfour and Bischoff slates and sandstones in North-Western Tasmania are correlated with this series. Lithologically and structurally it is very similar to the Ordovician system in Victoria, but no graptolites have yet been found in it.'

The rocks of the cutting at Warrentinna consist of slates and sandstones. The latter are pink or yellow in colour, and most are fine-grained. The plant-remains occur in a few narrow beds of sandstone adjacent to bands of slates. The fracture of the sandstone is very uneven, so that only small lengths of plant-stems are evident on the exposed surfaces. These are preserved as flattened incrustations in the sandstone. In the majority of examples the flattened cast of matrix is enclosed by a thin layer of a brown mineral which represents the transformed outer tissues of the stem. Occasionally, as in fig. 6, small carbonaceous particles may remain on the outer surface of the incrustation, or, as in fig. 2, on the inner surface of the concave mould after removal of the core of matrix.

Description of Plant Remains

The plant-fragments collected at Warrentinna are of strikingly uniform character, and are devoid of special diagnostic features. For this reason they cannot be specifically identified, and only tentative comparisons can be made. Most are unbranched, smooth stems, from 1-5 mm. in width and 6 cms. or less in length. The longest piece of stem found is represented of natural size in fig. 1. It has a width of 2 mm., and a length of 6 cms. is exposed on the rock. The surface is non-striated, and shows no evidence of appendages. A similar fragment is shown in fig. 2. In this case the core of matrix has fallen out from the greater part of the incrustation, and has left a thin layer of brown material, with small carbonaceous particles to represent the outer tissues of the stem. Fig. 3 represents another stem-fragment, 2 mm. wide and 3·5 cms. long. The incrustation in this case is much flattened, and in the upper portion the sandy

cast has come away, exposing a median longitudinal ridge. It is possible that this ridge indicates the position in the stem of a median vascular strand, but there is no evidence to substantiate this.

A few branched stems were found at Warrentinna. These provide more definite characters for comparison with early plants from other countries, and therefore are of greater value than the more numerous unbranched fragments. The specimen shown of natural size in fig. 4 shows the division of a stem 5 mm. wide into two equal daughter-axes. The latter are each 4 mm. in breadth. A second branched example is represented at a magnification of 5 diameters in fig. 6. In it the relatively main axis, which has a diameter of 1 mm., gives off at right-angles a small lateral branch. Both examples are disconnected pieces of stem, and have a Y-shaped form. Their appearance suggests that the branching was probably based on a dichotomy.

Although the fragments just described cannot be specifically identified, a comparison with fossil plants from other localities is fully justified. The age of the Warrentinna plants is not actually determined, but is clearly pre-Devonian, since the Mathinna series are intruded by granites of Devonian age. The natural comparison is therefore with the Silurian plants of Eastern Victoria. Plant-containing beds of Upper Silurian age occur on the mainland along the Walhalla Geosyncline at Gaffney's Creek, Wood's Point, Walhalla, and further south on the coast at Livingstone Creek, Waratah Bay (Lang and Cookson, 1927, 1935). From these localities slender, smooth, branching stems of similar type to those from Warrentinna have been described under the form-genus *Hostimella* sp. Some have shown a more detailed comparative feature in the presence of a small oval area on the surface of the incrustation in the angle between the main axis and the branch. This axillary 'bud' is also represented in some of the smooth-branched axes from the Middle Devonian of Scotland (Lang, 1925), and in *Hostimella hostimensis* from the Middle Devonian of Bohemia (Potonie and Bernard, 1904). A close comparison of the Victorian stems with some remains from the Devonian of the Northern Hemisphere has therefore been established.

The specimens from Warrentinna come within the range of size met with in the Victorian specimens named *Hostimella* sp., and the Y-shaped fragments are also in agreement (Lang and Cookson, 1930, figs. 1 and 4). None shows, however, the presence of an axillary 'bud,' the presence of which would provide a distinctive and satisfactory basis of comparison. The identification of the present material as cf. *Hostimella* sp. is given on the understanding that such a designation is purely descriptive and probably includes plant types of varied affinities.

A single, rather obscure specimen which differs from the above-described stems must be mentioned. It is shown magnified 3 diameters

in fig. 7. In it the smooth axis, which is 1 mm. wide, shows a terminal subdivision into three more slender daughter-axes. Two of these are shown in the figure, the third, which lay beneath the rock on the left-hand side, having been exposed only after the subsequent removal of the covering-stone. During this operation portion of the middle branch came away, so that it is impossible to support, with an illustration, this more complete description of the specimen. The right-hand daughter-axis shows an early and equal division into two more slender branches, and there was some evidence that the middle axis branched in a similar manner. The third daughter-axis on the left-hand side (not shown in the figure) lies at a slightly lower level, and partially underlies the centrally-placed branch. It has not been possible to determine whether or not it also underwent bifurcation. The distal regions of the branch-system have not been preserved. Comparisons of such an incomplete specimen must be made cautiously, and can only be tentative. The only type with a terminal branch-system to which this specimen is at all similar is *Hedeia corymbosa*, a fructification described and known from the Upper Silurian at Alexandra, Victoria (Cookson, 1935, figs. 25 and 26). The main axis is more slender than in any known specimen of *H. corymbosa*, and since no information as to the terminations of its branches is available, this passing reference to a possible similarity of construction is sufficient.

Conclusion

No evidence has been obtained that the specimens from Warrentinna were parts of vascular plants, but their general appearance suggests that they were most probably portions of land plants. They have been compared with the smooth-branched axes of the type known as *Hostimella* sp., which are abundant constituents of many early Palaeozoic floras.

The question of the age of the Mathinna series is raised by the occurrence of these plant-remains. There are no records of land plants in the Ordovician. The oldest vascular plants at present known with any completeness are those from the Upper Silurian of Victoria, types of which have been used for comparison with the Tasmanian fragments. If the latter are vascular, as seems probable from their general appearance, and if the beds containing them are definitely proved by other means to be Ordovician, the interest in these plant-remains will be greatly increased. Mr. Nye, in his paper previously referred to, gives the age of the beds as Cambro-Ordovician, and draws attention to the lithological agreement with the Ordovician rocks of Victoria. He particularly mentions, however, the absence of graptolites and other fossils, by means of which an exact determination of age could be made.

The plant-containing sandstones at Warrentinna are also very similar lithologically to the plant-beds at Wood's Point and other localities in the Victorian Silurian, the irregular, conchoidal fracture being an additional point of agreement. The Silurian plant-bearing sandstones on the Victorian coast near Waratah Bay, with fragments which agree closely with those from Tasmania, are of particular interest in this connection. They are the nearest geographically, and are situated almost in a direct line north from the Tasmanian area. Although plants are not usually a satisfactory index of precise age, in this case, where the age appears to be a somewhat open question, they assume considerable importance. The presence of plant-remains in the Mathinna series, and their agreement with similar remains in Victorian Silurian rocks, renders it very probable that there is error in placing the beds as Cambro-Ordovician, and points to a higher level, presumably near the Silurian of Victoria.

The small fragment which shows some points of agreement with *Hedeia* from Victorian rocks is not sufficiently well defined to be used in support of a relationship between the Victorian and Tasmanian series. Its occurrence, however, increases the possibility that future work may result in the establishment of a more complete and comparable flora in the pre-Carboniferous rocks of Tasmania.

Summary

1. Plant fragments have been described from rocks mapped as Cambro-Ordovician in North-Eastern Tasmania.

2. Some have been identified as cf. *Hostimella* sp.

3. A comparison with Silurian plants from Victoria is made.

4. The suggestion is put forward that the plant-bearing-series may later be proved to be of Silurian age.

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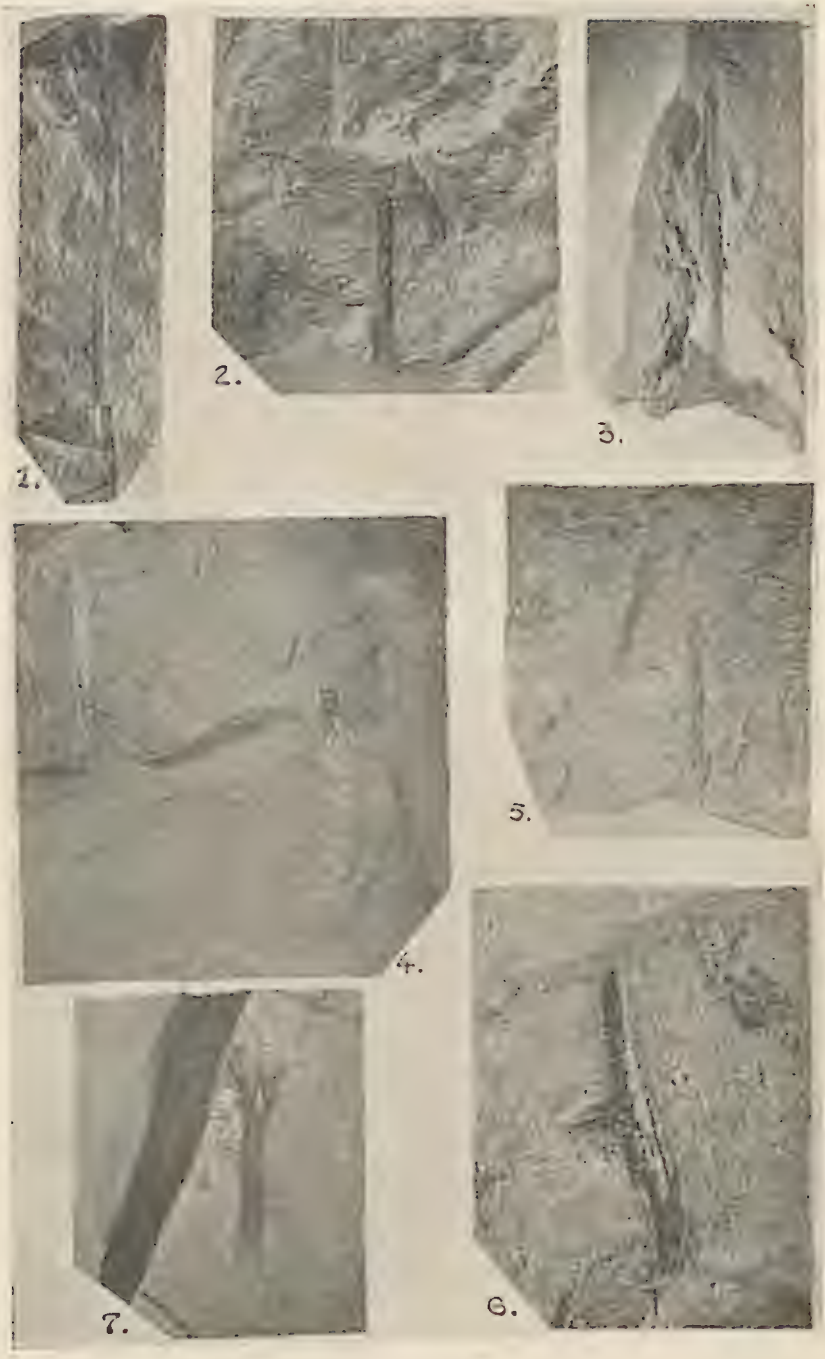
Explanation of Plate XX

(All the figures are from untouched negatives. The figured specimens will be housed in the Mines Department, Hobart, Tasmania.)

Fig. 1. Cf. *Hostimella* sp.: An unbranched stem. (Nat. size.)
Fig. 2. } Cf. *Hostimella* sp.: Flattened incrustations, from each of which portion of
Fig. 3. } the core of matrix has been removed. (Nat. size.)
Fig. 4. A piece of sandstone showing plant-remains (cf. *Hostimella* sp.); one of these is branched and has a y-shaped form. (Nat. size.)
Fig. 5. Cf. *Hostimella* sp.: Two flattened incrustations, the right-hand specimen shows evidence of branching. (Nat. size.)
Fig. 6. Cf. *Hostimella* sp.: A small y-shaped fragment. (× 5.)
Fig. 7. *Incertae sedis*: A small branched axis. (Nat. size.)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A Sealing Voyage to Bass Straits by the Schooner 'Brothers' in 1813

By

W. E. L. H. Crowther

(Read 9th November, 1936)

It is a remarkable fact that, in spite of the many voyages from Sydney Cove, Hobart Town, and Port Dalrymple to procure sealskins and sea-elephant oil, the only sources of information as to the incidents of these expeditions have been short reports in colonial newspapers and in official communications from Sydney to the Home Government. The logs kept by the masters of these small craft have almost completely disappeared. MacNab, in his outstanding work on the early whaling and sealing days of New Zealand, being unable to consult such sources in the libraries of Australia and New Zealand, made the long journey to New England for this purpose. Some years ago, by a fortunate chance, an old log, bound in kangaroo skin and kept in the well-known hand-writing of Captain James Kelly, came into my possession. In it were the proceedings of two voyages: first, that of the 'Brothers,' which is described hereafter, and secondly that of the 'Mary and Sally' to Macquarie Island to take sea-elephant oil and sealskins. The dates of these voyages were respectively the beginning and latter end of 1813. Although there is little in them that is sensational, yet the daily routine of the ship is of great interest, and considerable light is thrown on the primitive methods of sealing and unstinted killing on the islands where the seals congregated. It was the custom at this period for a ship to procure salt from Kangaroo Island for the preservation of the skins. Their wood and water were obtained from the nearest source to the seal rookery, whether island or mainland, and beyond these their needs were few. At the period of this voyage the sea-elephants of King's Island had been practically exterminated, and no reference to them is made in the ship's log. The fur seals had, however, recovered somewhat from the wholesale slaughter of their herds in days immediately following the discovery of the Bass Straits sealing grounds.

Captain Kelly, it will be seen, touched at several islands in the Straits for a period of more than four months, before he was able to return to Sydney Cove with some 7000 skins.

His ship, the schooner 'Brothers,' had been launched just over four years before, at Cockle Bay, Sydney, to sail on her first sailing voyage five months later, on 5th January, 1809. In the next three years she made at least three voyages to Port Dalrymple and King's Island. The opening pages of the ship's log is unfortunately missing, and the journal commences on 3rd January, 1813, on the coast of New South Wales. The fur seal, which was the object of this voyage, was about 6 feet in length, the female being a foot less. The adults had a coarse fur of grey to yellow-brown colour, the ventral surface being darker, and under this was a rich chestnut underfur which persisted through life.

The identity of this seal is uncertain. Scott and Lord claim that the common seal of the Bass Strait Islands is *Aretocephalus tasmanicus* Scott and Lord. Bones of *A. cinereus* (Péron) have been identified by Professor Wood Jones from the kitchen middens of the Tasmanian aborigines, and this species may have occurred on the islands in Kelly's time. A third species, *A. doriferus* Wood Jones, may also occur on the islands of the Bass Strait.

The colonial schooner 'Brothers' left Sydney Cove in the first week of January, 1813, to take seals in the Straits. Captain James Kelly had with him a crew of at least ten men, in addition to his ship-keeping party; as is shown by a later entry in his log, when he landed a shore party of that number at one of the sealing rocks.

After a stay of a day at Twofold Bay, the ship proceeded to the southward, but owing to a strong head wind at noon on the 5th came to in the entrance of Barmouth Creek, anchoring with the small bower in 9½ fathoms. On the next day the bay was cleared, and with the anchor stowed the boat was got on board and the voyage was continued. Five days later a stop was made under the Capashine Island (Flinders Island) in 20 fathoms. Two hours later, the anchor having commenced to drag, all sail was made, and with the loss of her buoy rope the ship stood to sea. The same afternoon a boat's crew was landed at the Stacks, and later returned with 12 skins. Rounding the north point of Van Diemen's Land, and standing to the south-west and west, Captain Kelly cruised for four days, evidently in the hope of discovering uncharted rocks or islets where seals might be found. Being unsuccessful, however, and the weather being bad, he bore up to King's Island, and the vessel stood in towards the land. In a hard squall the fore-gaff carried away, but at 8 p.m. she came to in Elephant Bay in 8 fathoms with the small bower. The same day a boat was sent ashore for a spar with which to make a new fore-gaff, and next morning six casks of water, with two boat-loads of wood, were taken on board.

Weighing at 6 p.m. the 'Brothers' came to under Counsellor Island[1] at 8 p.m. with the best bower in 3½ fathoms; the ship's boat, however, only obtained three skins, the local sealers having probably cleaned up the rookery.

After repairing the rigging, the voyage was resumed on 23rd January; and, standing to the north-east, Phillips Island was in sight next day. The following day, running into Western Port, the 'Brothers' came to under the island in 5 fathoms, and the ship's boat, with the shore party, was sent to the seal island. Returning next day with 304 skins, the party of ten made daily visits, taking successively 314, 104, and 17 skins.

On 31st January a move was made to the south-west, and at 5 p.m. Point Schank was 5 leagues distant. Next day Albatross Island was passed, and the same day the ship came to under Hunter's Island with the small bower in 7 fathoms, Three Hummock Island lying east by north 5 miles. After moving to another anchorage on the next day, two boats were sent to the Seal Rocks to kill seal. The boat having returned with 17 skins and evidently a good report of the prospects at the rookery, the vessel was got under sail, and anchored further up the south part of the bay, mooring with a small bower to the south'ard and the best bower to the north'ard. The small boat was taken on shore to be repaired. Three days later, having collected wood, and the repairs being completed, two boats were sent to the Seal Rock, and returned in 48 hours with 375 skins. The large boat had, however, been stoved in the operations. On Tuesday, 9th February, the crew were employed salting the skins and repairing the large boat whilst the schooner was unmoored and got under weigh, to be brought to an anchorage further to the northward, and so more conveniently to the Seal Rock. Standing to the northward, at 6 p.m. the next day she came to in a sandy bay in 6 fathoms, and was moored fore and aft. Two boats left at 8 a.m. for the Seal Rock to kill seal, taking with them 12 bags of salt. In three days a cargo of 612 skins was brought back, and the log notes the crew during the next day as stowing them in the hold and doing other necessary jobs. The large boat was soon again in trouble, and on Wednesday, 17th February, having returned with the small one and a cargo of 460 skins, part of the crew were employed in repairing her whilst others salted the skins. On the 20th hard gales were experienced, and the fore topmasts and yards had to be housed. Opportunity was taken to send the water-casks on shore to be filled. As the weather allowed, the boats were employed between the ship and the Seal Rock, on some days the surf not permitting them to land there. A succession of gales brought about a serious state of

[1] No island of this name is shown on the charts of the early navigators to Bass Strait, nor is it on Admiralty charts. The rocks off the north end of Sea Elephant Bay are, however, still known lately by this name. Close study of the log of the 'Brothers' also places it in this locality.

affairs, and the log of the 26th reads as follows: 'The day commences with hard gales at east and rain. 11 p.m. the vessel labouring very much, parted the small bower.' On the Seal Rock, where the boats were hauled up, 'The surf broke so high that it totally wrecked the large boat to pieces, and the small boat was barely being repairable to bring the people off the Rock.' The gales having taken up, three days later, at 4 p.m., the remains of the small boat returned with all the people. They had been obliged to put a square stem on her with sealskins. On the Rock 220 skins had been left, all salted. The small anchor was weighed with the boat's aid, and the cable was found to be gone in three places. This was spliced the next day, when the best bower was hove up and replaced by the small one; during this operation, however, a buoy rope was lost. Seven days are entered in the log as being spent principally on shore repairing the boat; wood and water were also got on board. Having got up the yards and topmasts preparatory to moving off, at 7 a.m. of 7th March, Kelly sailed with a light breeze, sending at 10 a.m. the boat to the Seal Rock with a load of salt. More salt was sent the next day, with firewood, the boat returning at sunset, when the ship stood to the westward. At daylight the south point of King's Island was bearing W. by N. distant 7 or 8 leagues. At 10 a.m. the boat was sent to the Black Rock, off Seal Point (south end of King's Island), to kill seal, and returned in two hours with 51 skins.

Remaining at sea during the night, at daylight the 'Brothers' stood in towards Seal Point, and moored in Chapman Bay in 12 fathoms. The boat visited Seal Point and procured 20 skins. The seals being so few in number, a move was made to the northward after taking in water, hoisting in the boat, and stowing the anchor. Tuesday, 16th March, commenced with moderate breezes at S.S.W. At 2 p.m. the schooner came to under Counsellor Island in 4 fathoms. The boat was sent to the river to look for the small boat belonging to Mr. Blaxcell, but returned at 7 p.m., not having been able to find it. The log reads: 'We supposing Robert Knight to have her at New Year's Islands by finding his directions all round the island.' Weighing at 8 a.m. with a light breeze, at 3 p.m. the 'Brothers' came to off Coomses Bay in 13 fathoms, with the small bower. Seeing a smoke off Wig Point, the boat was sent on shore, and there found the small boat with Robert Knight, he having repaired her.

With this valuable addition to his equipment, Kelly at 1 p.m. weighed and sailed for New Year's Island, where he moored at 5 p.m. In the few remaining hours of daylight the boat obtained 120 skins from the islands. In spite of strong gales next day another 220 skins were obtained from the small island. The gales continuing, with smart showers of rain and hail, the following afternoon the crew remained on board salting skins, and the whaleboat was got on deck. The 21st and 22nd were also spent on board, shifting ballast out of

the run to trim the vessel, taking down the yards and topmasts, and stowing skins. Another trip of the boat to the small island resulted in its return with 72 skins, and the next day, the 24th, at 2 p.m., the vessel unmoored, and at 8 p.m. came to off the north end of Counsellor Island in 8 fathoms. From here, at 10 a.m., another move was made to Elephant Bay, anchoring there at noon. Heavy gales were experienced during the following two days, but firewood was got off from the shore and a change made in the crew, whereby one, Bundle, was discharged at his own request, and Charles Peterson and Christian, residents on King's Island, were taken on board. At noon the vessel was again at sea, with her course S.S.E., towards her former anchorage under Hunter's Island. Landing a boat-load of salt on the passage, at 9 p.m. she came to off the west end of Three Hummock Island. After 11 hours sail was made to anchor at noon in the harbour (by which is meant, probably, the sheltered inlet from which they had worked Seal Rock in the earlier part of this voyage. The 30th March saw yet another shift, this time to the westward, where at 4 p.m., in a sandy bay, a stop was made, and the boat sent to Seal Rock with salt and provisions. For seven days the boat plyed between the rock and the vessel, bringing back 700 skins. The 7th April is noteworthy owing to the cable of the best bower parting, when the small bower was let go, and so the ship brought up. The boat on the same day brought back 240 skins. Considerable anchor drill was the routine for next day, when, having bent the small bower to the cable of the lost anchor, the vessel was warped further out of the bay with the kedge. The ship's large grindstone was lashed to the kedge, and both secured to the cable of the lost best bower. The latter anchor they were not able to secure owing to the buoy not watering. With these precautions the ship safely rode out next day, during which hard gales blew from the east. When the weather permitted the lost anchor was swept for, but without success. On the second day the boat was sent to the Rock, and returned with 292 skins. On Saturday, the 17th, giving up the search for the anchor, a large stone was brought off from the shore, and slung to the small anchor to moor the vessel.

For the next three weeks the crew were employed partly taking seals and partly on the ship salting and stowing down. On various days cargoes of 200, 250, 230, 350, 370 skins were taken on board. When, on 8th May, the boat came alongside with 810 skins and four bags of salt it was a sign that the end of sealing at the Rock was in sight, although another load the next day of 255 skins and 5 bags of salt was brought to the ship. After wooding and watering and getting up the yards and fore topmast, on the 13th the 'Brothers' stood out of the bay; but, the wind coming in from the westward, anchored in the same place for the night. A last call at the Rock after weighing enable the people sealing there to come on board with yet another 352 skins. Calling on the 16th to the north end of

Counsellor Island, the small boat was left at the river on King's Island' at 8 p.m. with the best bower in 3½ fathoms; the ship's boat, 18th May the sea log was resumed as the vessel set her course for Sydney Cove, where she arrived and moored on 31st May, 1813. The last entry in the log in Kelly's writing reads: 'N.B.—This ends the voyage of the schooner "Brothers," being 7090 seal skins.'

The files of the *Sydney Gazette* give interesting information as to the subsequent career of the schooner. After another voyage to Hobart Town, returning on 30th October, 1813, and one to Port Dalrymple, terminating in April, 1814, she cleared for New Zealand in June of the following year. In company with the 'Trial' a serious encounter took place with the Maoris at Trial Harbour (named after the vessel), near the River Thames.

These little ships had been trading for flax along the New Zealand coast, and returned to Trial Harbour to pick up flax the natives had promised to have ready for them. At noon on Sunday, 20th August, both vessels, in spite of having rigged boarding nets to prevent such an occurrence, were taken by the Maoris. The crews took refuge between decks, and from there and through the cabin skylight kept up a harassing fire with their muskets. Not accustomed to this type of warfare, and losing heavily, the Maoris quitted the decks. One of their number, however, who had had experienced with ships, cut the cables, and both the 'Brothers' and the 'Trial' went ashore. The crew of the latter, almost desperate, with a volley of seven muskets regained their own ship, and by using their swivels as well as the muskets drove off the natives from the 'Brothers.' Later the vessels were refloated and resumed their voyages. In this affray both ships lost several of their crew. A detailed account of the affair is given in the *Sydney Gazette* of 8th November, 1815.

Next year the 'Brothers' was lost on the Kent's Group, probably returning from Port Dalrymple with a cargo of wheat. Mr. Howell, the master, and ten men existed for ten weeks on the wheat that was washed on shore. Only one man of the crew was lost.

Captain Kelly had by this date permanently associated himself with Van Diemen's Land, his famous circumnavigation of the island having terminated early in 1816. Some details of his early seafaring as a sealer and whaler may be read in his evidence given before Mr. Commissioner Bigge.

ACKNOWLEDGEMENT.

I have to thank Miss Leeson, of the Mitchel Library, and Dr. F. Wood Jones for help in compiling this paper. Much detailed information as to sealing in these waters is contained in a thesis by the late L. C. Murray, B.A., presented to the University of Tasmania in 1927. This account has been of the greatest help to me.

The Problem of the Tasmanian Aborigine

By

A. L. Meston, M.A.

(Read 10th August, 1936)

On the evidence of a chalcedonic flake, W. H. Twelvetrees (1917) concluded that the Tasmanian aborigine had inhabited this island for, humanly speaking, a vast number of years. This flake was found by Mr. Richards while sluicing for tin at the old Doone Mine, north of Ringarooma River. The alluvial tin bed was overlain with drift from 10 to 20 feet deep, which had to be removed before the wash gravel was exposed. At the time of the discovery the sluicing nozzle was at the bottom of an excavation half a chain wide, 10 feet long, and 25 feet deep. Ten feet below the surface of the ground, and in consequence 15 feet above the bottom of the excavation where the hydraulic nozzle was being handled, a block of wash was detached from the cliff face. On the top of this block, *slightly* adherent to the gravel, Mr. Richards discovered the flake. It was shown to R. M. Johnston, who pronounced it as undoubtedly of human workmanship. I do not question its human origin, but in face of all the facts I cannot accept the view that it belonged to the alluvial gravel, which, according to Sir Edgeworth David's computation, dates back to the Riss glaciation, or about 100,000 years ago. The artifact as figured and exhibited bears a remarkable likeness, in respect of shape and retouch, to those we find to-day on the surface of the ground. It shows, as Sir Edgeworth David (1924) remarked, an 'extreme freshness,' that is there is a 'remarkable absence of weathering'; nor is it at all waterworn, although it was adherent to the alluvial wash, which was well waterworn. When picked up it broke into two pieces, one of which was thrown away. An examination of the plane of fracture revealed that there was a deposit of silica on the surface, and Twelvetrees stressed this as important evidence of its age as an artifact; for he inferred that the silica had been deposited in a fracture that had developed after the artifact was dropped. Such an inference is unfounded, because it is not uncommon to find recent artifacts in which there is a deposit of silica in a fracture, the aboriginal maker having made

use of a pebble containing such a flaw. The hydraulic nozzle was used not only for disintegrating the alluvial wash, but also for getting rid of the overburden. Twenty-five feet below the surface of the ground the water was directed from the nozzle against the overburden, at this place 10 feet deep. When this was removed a face 15 feet high was left, the top of which was invisible from below. There seems to be no doubt that the stream of water washed the artifact from the surface, or from just below the surface, to the top of the alluvial, and it stuck there, not tightly, however, for it was only slightly adherent. When the water was turned off a subsequent examination revealed the flake, the peaty clay of the overburden providing an admirable adhesive. It is important to remember that no one could say exactly from what part of the face the detached mass came, and that no one saw the artifact on the block while it was *in situ*.

Dr. A. Lewis (1935) states that on the New Norfolk-road, near the 13th milestone, there is a mirnyong or midden that accumulated in the warm interglacial phase known in Tasmania as the Yolande-Margaret interglacial period, which he tentatively correlates with the Riss-Würm interglacial of the Northern Hemisphere. The date of this midden varies according to the authorities he quotes. It may have been formed as far back as 200,000 years ago, at the latest at least 100,000 years. His claim for such antiquity rests on three data: first, that the midden lies in a Yolande-Margaret terrace; secondly, that it is overlain by many feet of soil; and, thirdly, that the shells composing it belong to the open sea, and could not exist in the estuary in its present form. I will deal with these *seriatim*. That the terrace belongs to the Yolande-Margaret interglacial I do not dispute, but it has existed very much in its present form for many centuries past, and could have been used as a camping-ground 100 years ago just as well as 100,000 years. Since the white occupation of Tasmania, the ground has been cultivated, and the consequent shifting of the soil has caused shells on the roadside to be overlain by a few feet of earth; back from the road the shells are merely on the surface. Soil-creeping brought about by ploughing is a well-known phenomenon. Moreover, all the shells are remarkably fresh-looking. But it is on his last datum, that the mollusc shells found on the midden are such as could not exist except in the open sea, that almost the whole of his case depends. And here it falls to the ground. Not two chains away, on the banks of the river immediately below the midden, the very molluscs, *Modiolus confusus*, that he declares could not exist in the estuary in its present form, may be collected in countless thousands. The molluscs found on the midden, therefore, can, and do, exist in the estuary at the present day. From the zone of shells overlain by soil and from the surface of the midden I gathered a few worked flakes, in no way different from the flakes which may be picked up on the surface far and wide throughout Tas-

mania. This midden has every mark of recent origin, and is typical of the hundreds scattered throughout the island. The terrace faces the north, is composed of a sandy soil, and is protected from cold winds. A collector of aboriginal stone implements would inevitably look for a native camp at such a site. This midden does not, in my opinion, afford the slighest foundation for assuming that man has inhabited Tasmania for the long time, 100,000 years or more, that Dr. Lewis affirms.

During the last 30 or 40 years great interest has been aroused among physical anthropologists by the discovery of such primitive types as *Palaeanthropus* or Heidelberg man, *Pithecanthropus* or Java man, *Eoanthropus* or Piltdown man, and *Sinanthropus* or Peking man. They became extinct long before *Homo sapiens* was differentiated. Nor did Neanderthal man, who inhabited Europe during the Würm glaciation, belong to this species. The original home of *Homo sapiens* is not definitely known, but it is universally accepted that the species arose in either Africa or Central Asia.

The Aurignacians, whose culture had many affinities with the Tasmanian, were the first representatives of *Homo sapiens* to enter Europe. They crossed from Africa to Europe by a land bridge when the last or Würm glaciation was retreating. If we adopt M. C. Burkitt's (1933) computation of the date of the Würm glaciation based on the varve counting of de Geer, they entered less than 20,000 years ago. Elliott Smith, in his 'Human History,' dates it at 10,000 years ago. Of course there is nothing to prove that the Aurignacians invented the culture they possessed, but most authorities agree that their culture was not more than from twenty to forty thousand years old. The Aurignacians, the Tasmanian aborigines, and all peoples living to-day belong to the species *sapiens*. As no evidence of this species exists in Europe before the Aurignacians, it is clear that its dispersion was, in the geological sense, relatively recent. This goes far to disprove the idea that *Homo sapiens* existed in Tasmania more than 100,000 years ago.

The Tasmanian aborigine had the dark skin, flat nose, and wide nostril which are adapted to hot climates, but are disadvantageous in cold regions. He had also closely twisted hair and full, fleshy lips. In other words, he was a Negroid. The Negroids of the world may be divided into two main groups, widely separated geographically: the Negroes or Africans, and the Melanesians of Oceania. The Negroes occupy the whole of Africa south of the Sahara, and on the west coast extend to Morocco; the Melanesians occupy New Guinea, the Bismarck Archipelago, the Solomon Islands, New Caledonia, and Fiji. The Melanesians show much the same general characteristics as the Africa negro, but in a form suggesting admixture with other races. All this points to an original home for the Negroids, but its actual geographical situation remains a puzzle. It may have been

somewhere in the tropical regions midway between Africa and Papua, but the fact that the distinctive negro characteristics are more obtrusive and constant in Africa tends to suggest that the Negroids originated in that continent. As these negroids migrated towards the east there would be some admixture with the peoples with whom they came into contact. This would weaken some of the original distinctive features. Anthropologists have frequently commented on the existence of individuals among the negroids of the Solomon Islands and elsewhere whom they could not distinguish from Australians. This probably indicates an intermingling with Australians. Similar interminglings must have occurred throughout the centuries during which the migration took place.

When we come to ask how the Tasmanians reached Tasmania we find considerable diversity of opinion. The oldest theory of all is that the Tasmanians entered from Australia by a land-bridge. But, as Dr. Lewis (1935) points out, such a land-bridge could have existed only during Malannan times—that is, well over 100,000 years ago. There is no evidence that *Homo sapiens* had yet evolved, and it is quite certain that no culture equivalent to that reached by the Tasmanian had come into existence. These facts make it impossible to accept the land-bridge theory.

Of recent years another theory has arisen of which Professor Wood Jones (1935a) is the chief exponent. The adherents to this theory affirm that Tasmania has been peopled direct from New Caledonia, an island lying between 20° 1′ S. and 22° 26′ S., and more than 1700 miles distant. Either the New Caledonians deliberately sailed away into the unknown in search of land, or a boat-load, containing at least one young woman, was blown away in a storm, and eventually, after suffering dreadful hardships, was washed ashore on the Tasmanian coast. There are many difficulties in the way of accepting this theory. In the first place, the Melanesians, unlike the Polynesians, were not sea rovers, and did not make long ocean voyages. Their distribution is confined to island chains. This in itself is enough to compel us to reject the idea that Tasmania was peopled by them as the result of a deliberate voyage far out into the distant unknown. They could reach New Caledonia by making use of a chain of islands, but no island chain exists, or has existed within human experience, between New Caledonia and Tasmania. With the exception of two small islands, Lord Howe Island and Norfolk Island, mere specks on the ocean's bosom, a vast unbroken expanse of sea rolls between the two. There remains the alternative that a boat-load was cast ashore on Tasmania as the result of a storm or a series of storms, and that there were survivors. This is so wildly improbable and fantastic as to be regarded as impossible. Apart from the great time involved in drifting 1700 miles in a direct line, in an open boat, with a blazing sun overhead, and a shortage of food and water, there is another aspect. New Caledonia is situated

in a region where the south-east trades are constant throughout the year. This wind is so strong that, although Tasman was in a well-found ship, he could not make his way through Torres Strait against it. Cook nearly suffered shipwreck on the Great Barrier Reef because the great waves raised by this wind swept the ' Endeavour ' towards it. Had he not found an opening in the nick of time there is nothing surer than that the ship would have been dashed to pieces. The south-east trades blow from New Caledonia towards the coast of Queensland. To reach Tasmania, therefore, the New Caledonians must voyage against a constant wind and high sea.

In further proof that Tasmania was peopled by a few voyagers from New Caledonia the paucity of numbers of the Tasmanians is cited. It is assumed that if more than a canoe-load had reached the island, there would have been many more natives living there when the first white settlers arrived. Opinions differ as to the number. Backhouse estimated that there had never been more than 1000; Robinson put the number as between 6000 and 8000; Milligan said 2000. A comparison with the number of the aboriginal inhabitants of Victoria before white settlement is illuminating. Wood-Jones (1935b) estimated that at the foundation of Victoria about 6000 aborigines lived there. The greatest estimate of their number is that of E. S. Parker, 7500; the smallest that of George Augustus Robinson, 5000. Robinson worked on the basis of the distribution of one aborigine to each 16 square miles of country. If Victoria, with its less rigorous climate, greater area, and great plains stocked with game, could maintain an aboriginal population of but 6000, Tasmania could not maintain nearly so many. If we adopt Robinson's basis of computation, the aboriginal population would be fewer than 2000. And this is the estimate one arrives at from the various accounts of numbers observed at different places. A small population, however, by no means necessarily implies that the first settlers were few. Density of population is strictly limited by the food supply. Tasmania had no edible fruits, berries, or nuts worth mentioning, no edible roots of much account, and no grain plants to offer the aborigines. The cold of the central plateau in winter drove the natives to the sea-coast. The wet forests of the west coast and the great extent of barren, rugged country precluded habitation then as it does now. We have only to note what little use we can make of more than half Tasmania to realize that it had little to offer a race of food-gatherers. The natives had to struggle hard for a meagre existence. Geographic control has always been a powerful agent in restricting population. At the advent of the white race the native population was stationary, for saturation point, so to speak, had been reached.

If the aboriginal voyagers were able to surmount the difficulties of adverse winds, seas, and currents, it is obvious to all that such a voyage demands a boat much more substantial than that which the

Tasmanians possessed when discovered by white races. The upholders of this theory surmise that the descendants of the castaways forgot how to build substantial boats. There is no doubt that such degeneration does actually take place. Dr. Codrington (1891) states that in the Torres Islands (not to be confused with the islands of Torres Straits) the canoe-makers had died out, and the islanders acquiesced in the loss of what had proved of great use to them. The inhabitants of Mangareva are also credited with having lost the art of canoe-making. But it is difficult to believe that the Tasmanians forgot how to construct the substantial sea-going canoe, yet remembered perfectly how to construct that type of canoe which their ancestors had made thousands of years before (see Meston, 1936, p. 159).

The Tasmanian canoe was not suited for long ocean voyages. It is probable, therefore, that the Tasmanians came to Oceania by way of the chain of islands known as the East Indies. Even supposing, and there is no ground for such an assumption, that many of the islands now existing were joined to Asia and Australia when the migration took place, there was never a time in human history when there was continuous land between the two continents. The East Indies are divided by a sea passage known as Wallace's Line, which has existed for so long a period that the indigenous mammalia on the opposite sides of it are as widely divergent as in any two parts of the world. This line separates Borneo from Celebes, and Bali from Lombok. Whatever land-bridges man had, he must always have had to cross the 15 miles of sea between Bali and Lombok or the wider Macassar Strait between Borneo and Celebes.

Professor Huxley (1870) named as the nearest living representative of the Tasmanians 'the inhabitants of New Caledonia and those of the islands of Torres Straits and New Guinea.' Professor Wood Jones (1935a) makes use of Huxley's statement, but omits the reference to the islands of Torres Strait and New Guinea. Surely it is strange, if, having reached the islands of Torres Straits, the negroid migrants did not reach Australia, which lay in sight, although they proceeded east and south by way of the New Hebrides to New Caledonia. The most reasonable explanation is that these eastern negroids crossed to the mainland of Australia and settled there. They would in course of time, without any external drive, gradually move southwards. This is supported by the high percentage of skulls in the southern half of Australia which show Tasmanoid characteristics. Professor Wood Jones (1935a) explains them as a result of an intermingling of Tasmanians with Australians since the coming of the English. While it is true that Tasmanian aborigines did cross to Victoria after white settlement, they were so few in number and their opportunity for intercourse with the mainland native was so little, that such an explanation is totally inadequate. Nor will it suffice to account for the number of skulls with marked Tasmanoid characteristics which have been found in Queensland.

The main objection that Professor Wood Jones has to the theory that the Tasmanians came by way of Australia is that they neither learned to domesticate the dingo nor to assimilate any of the main cultural features of the Australians. He assumes that the Tasmanians were driven out by the invading Australians, and in their flight reached Tasmania. But it is equally valid to consider that the Tasmanians formed the advance guard of the negroids, and voluntarily migrated across Bass Strait without coming into contact with the Australians, reaching Tasmania in a way similar to that whereby their negroid relatives reached the New Hebrides and New Caledonia. Once Australia was reached there would be a gradual move southwards along the coast until Bass Strait itself was reached.

The supporters of the land-bridge theory raise two objections to such a crossing. First, because, they say, the Tasmanians had no vessels capable of crossing Bass Strait; and, secondly, that it is difficult to imagine a primitive people setting out for a land which lay over the horizon, and of the existence of which they must have been entirely ignorant.

Let us examine these objections. That the Tasmanians did not possess seaworthy craft is quite erroneous. Primitive though their bark-bundle canoes were, they voyaged regularly to the islands which fringe our coasts, crossing not only sheltered waterways, but facing the great swell which perpetually rolls in from the Southern Ocean, or the steep ugly seas and racing tides which guard the islands at the western end of Bass Strait. Nor did they always wait for calm weather. They have been seen, for instance, to visit the Mattsuyker Islands, off our southern coast, in the midst of a storm.

An examination of the Admiralty Chart 1695A shows that the second objection is based on a geographical misconception. A string of islands, none of which is 25 miles distant from the next, stretches all the way from Wilson's Promontory to the mainland of Tasmania. In crossing Bass Strait by this route one is never out of sight of land, and land with a bold outline; so that the Tasmanian aborigines by using this route would not be setting out for a land which lay over the horizon beyond their ken.

From Deal Island, 35 miles north-west of Flinders Island, both Wilson's Promotory and Flinders Island are clearly seen, as well as the intermediate islands, which form, as it were, giant stepping-stones. On Hogan Island and on Deal Island there are abundant and permanent supplies of fresh water. There is no need to say that this is true of Flinders, Cape Barren, and Clarke Islands.

From all this it follows that the aborigines could voyage to Tasmania by way of the Hogans and Kent Group without crossing a sea-lane wider than 25 miles, and with permanent fresh water at no stage of the journey at a greater distance than 35 miles. Shellfish, seals, and mutton-birds, and on the larger islands wallabies,

wombats, and opossums, would provide them with a bountiful food supply. Such a voyage would offer little difficulty. Their ancestors had to cross much wider sea-lanes on their migration; and longer voyages in canoes quite as primitive are made elsewhere in the world. Sollas (1915), for example, tells us that in their primitive canoes or balsas the Seri Indians cross the Gulf of California, a distance of from 50 to 100 miles. And it must be remembered that the total distance from Wilson's Promotory to Flinders is less than 90 miles, with two excellent stopping-places.

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The Royal Society of Tasmania

Annual Report

1936

The annual meeting was held at the Society's Rooms, Tasmanian Museum, Hobart, on the 8th March, 1936.

The following were elected as members of the Council for 1936:—Mr. S. Angel, Mr. H. Allport, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. V. V. Hickman, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin, Mr. F. E. Ward.

His Excellency the Governor nominated the following members as Vice-Presidents:—Mr. F. E. Ward and Mr. V. V. Hickman.

The Council at its first meeting made the following appointments:—

Chairman of the Council: Mr. W. H. Clemes.
Secretary: Dr. Joseph Pearson.
Hon. Treasurer: Mr. S. Angel.
Standing Committee: Mr. Unwin, Dr. Lewis, and Dr. Pearson.

Representatives of the Society on the Board of Trustees of the Tasmanian Museum and Botanical Gardens:—Mr. W. H. Clemes, Dr. W. L. Crowther, Dr. A. N. Lewis, Mr. S. Angel, Mr. E. E. Unwin, Hon. L. M. Shoobridge.

Nine meetings have been held during the year, and, in addition to the lectures delivered, scientific papers of considerable value and interest were submitted for publication.

(See abstract of meetings for abstracts of lectures, papers, &c.)

The Society's library still continues to be of service to members and others desiring scientific and historical information. During the year 479 volumes have been added, bringing the total up to 18,733.

Mrs. Clive Lord continues to act as Assistant Librarian, and under her supervision the library is gradually being reorganized, and a distinct improvement has already manifested itself.

The Government has again assisted with the printing of the Papers and Proceedings, and this concession is greatly appreciated by the Council.

The membership for the year, compared with that of 1935, is as follows:—

	1935.	1936.
Honorary members	4	3
Corresponding members	4	3
Life members	7	7
Ordinary members	229	223
	244	238

During the year 11 names were removed from the membership owing to deaths, resignations, &c., and five new members were added.

The Council regrets to have to record that the following members have died during the year:—

Mr. R. W. Giblin.

Mr. L. Rodway.

The Late Leonard Rodway, C.M.G.

The Council wishes to make special mention of the late Mr. Leonard Rodway, who died on 9th March, 1936, in his eighty-third year. Mr. Rodway was the son of Henry Barrow Rodway, of Torquay, Devon, England, and was born in Torquay on 5th October, 1853. He was educated in Birmingham, and later served full time on the Officers' Training Ship 'Worcester,' and passed out with a double first-class extra certificate, a position very seldom obtained; he also passed under steam for the Royal Navy, and was three years midshipman in the George Marshall service.

Having left the sea and gained the Licentiateship of the Royal College of Surgeons of London, Mr. Rodway arrived in Tasmania in 1880, and joined the Royal Society of Tasmania four years later. He had always been a prominent member, and had been a member of the Council since 1911, at one time holding the position of Chairman. For some years he was Senior Vice-President of the Society, and was a trustee of the Tasmanian Museum and Art Gallery and of the Botanical Gardens. He was appointed Honorary Government Botanist by Sir Edward Braddon in 1896, a position he had held ever since, and it was in the field of botany that Mr. Rodway had performed such outstanding work on behalf of the State; but he had done meritorious work of a civic and scientific nature generally. For

THE LATE LEONARD RODWAY, C.M.G.

instance, he was for many years a member and sometime Vice-Chairman of the Technical School, and for thirty odd years was on the staff of the General Hospital as Honorary Dentist. He performed splendid work for many years as a member of the Domain Improvement Committee; he was Chairman of the National Park Board, and for many years Chairman of the Tasmanian Field Naturalists' Club; he was President of the Sandy Bay Rowing Club and the Tasmanian Branch of the Royal Life-Saving Society, and was prominent in the University Extension Lectures and the Workers' Educational Association. He was a member of the Scenery Preservation Board and also Advisory Officer to the Forestry Department, and for some years Lecturer in Botany to the University.

Mr. Rodway made notable researches in the botany of Tasmania, and, in addition to numerous papers contributed to the Papers and Proceedings of this Society, he found time to compile a comprehensive work on 'The Flora of Tasmania,' as well as smaller handbooks on 'The Wild Flowers of Tasmania,' and a complete description of the Mosses and Hepatics of the State.

Mr. Rodway was awarded the Clarke Memorial Medal of the Royal Society of New South Wales and the medal of the Royal Society of Tasmania for his botanical researches. In 1917 he was awarded the C.M.G. by His Majesty the King, in recognition of his services to the State and to botanical science.

At the monthly meeting of the Society held on 6th April, 1936, the following resolution, proposed by Dr. A. N. Lewis, and seconded by Mr. W. H. Clemes, was carried:—

> 'That the Royal Society place on record its appreciation of the outstanding work done by the late Mr. Leonard Rodway, C.M.G., and his services to the Society and to the State; and that a letter of condolence be sent to Mrs. Rodway and to the family of the late Mr. Rodway.'

At the monthly meeting of the Society held on 11th May, 1936, it was announced that the Trustees of the Tasmanian Museum and Art Gallery had decided to make a public appeal for funds to provide a memorial to the late Mr. Rodway. The Royal Society of Tasmania agreed to co-operate with the Trustees in this matter. Subsequently a public meeting was called on 22nd July, 1936, when it was decided to issue an appeal to the public for subscriptions in order to establish a memorial to the late Leonard Rodway, and it was agreed that the money so collected should be expended as follows:—

(1) A portrait of Mr. Rodway to be painted by his daughter, Mrs. Moore (Florence Rodway).

(2) The balance to be applied to the purchase of botanical books for the Royal Society's library, such books to be suitably inscribed to indicate that they form part of the Rodway Memorial.

In response to the public appeal the sum of £93 14s. 6d. was collected.

The Council has pleasure in announcing that Mrs. Leonard Rodway has presented her husband's botanical library to the Royal Society. In accepting the gift the Council, after consulting the Trustees of the Tasmanian Museum and Art Gallery, decided to provide room for this library in the Museum herbarium, where it would be at the disposal of botanical students. It was further decided that the library shall be known as 'The Rodway Memorial Library,' and so labelled.

The family of the late Leonard Rodway presented to the Society the Clarke Memorial Medal of the Royal Society of New South Wales and also the medal of the Royal Society of Tasmania. Dr. Rodway, eldest son of the late Leonard Rodway, offered to lend his father's C.M.G. decoration. These offers were gratefully accepted, and it was decided that the medals should be placed in a suitable case, and displayed beneath the portrait of Leonard Rodway, which, when completed, will be hung in the Art Gallery.

Aboriginal Rock Carvings at Mount Cameron West

Concern has been expressed regarding the deterioration of these rock carvings, due to weathering and other causes, and it was suggested that steps should be taken either (*a*) to remove samples of the carvings to a safe place, or (*b*) to have casts made which could be placed in the Tasmanian Museum and other museums.

The Council decided to invite Mr. N. B. Tindale, Ethnologist to the South Australian Museum, to visit Mount Cameron West, and report to it as to what, in his opinion, would be the best procedure. With this end in view the Government was requested to make a grant towards the cost of bringing Mr. Tindale to Tasmania, and the Government agreed to make a grant of £30 for this purpose. Ultimately this was increased to £50 15s. 10d.

Mr. Tindale visited Tasmania in April, and, with the Secretary (Dr. Pearson) and Mr. A. L. Meston, visited the rock carvings at Mount Cameron West. Later Mr. Tindale presented a report, in which he recommended that immediate steps be taken to remove about seven of each of the large boulders to the Tasmanian Museum, and that the remaining inscriptions should be, if possible, protected from further weathering by a special treatment of the surface of the rock.

On his way back from Mount Cameron West Mr. Tindale inspected the rock carvings at Devonport, and it was his opinion that one or two outstanding examples of these should be removed to safe keeping

in a museum, and that in addition plaster casts of all the other examples should be prepared for preservation in the National Collection at the Tasmanian Museum.

As the rock carvings at Mount Cameron West are situated on the property of the V.D.L. Company, the Council of the Society requested the Company to give the Council powers to carry out Mr. Tindale's recommendation. The Council is glad to report that the V.D.L. Company, through Mr. A. K. McGaw, C.M.G., has agreed to permit of the removal of any specimens which may be necessary in accordance with Mr. Tindale's report. The only thing that now remains to be done is to approach the Government, to obtain from it financial assistance in order to carry out the scheme which Mr. Tindale proposed. This will be done during the year 1937.

Abstract of Proceedings

1936

9th March, 1936

Annual Meeting

The annual meeting was held at the Society's Rooms, Tasmanian Museum, on this date, the President, His Excellency the Governor, Sir Ernest Clark, K.C.B., C.B.E., presiding.

The following were elected as members of the Council for 1936:—Mr. H. Allport, Mr. S. Angel, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. V. V. Hickman, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin, Mr. F. E. Ward.

The President appointed the following two Vice-Presidents:—Mr. F. E. Ward and Mr. V. V. Hickman.

Mr. Walter E. Taylor was appointed Hon. Auditor.

An interesting paper by Mrs. J. McElroy on 'The Times and Some Contemporaries of Lieutenant-Colonel Paterson, Founder of Launceston,' was read by Mr. Wilfred Hudspeth, in the unavoidable absence of the authoress, of which the following is an abstract:—

> The writer stressed the fact that the key to early Tasmanian history lay in a good knowledge of the early history of the Mother Colony, New South Wales, whose dependency Tasmania was from the first settlement in 1803 to 1825. Governor King's difficulties with the rebellious New South Wales Corps, the 'Rum Corps,' were outlined, and an account given of Colonel Paterson's famous duel with Captain Macarthur, and also of the dispute between King and Captain Colnett, of H.M.S. 'Glatton,' which led to the unjust recall of the Governor. It was noted that Mrs. Paterson and Mrs. King were the first ladies to sit on any Australian committee, that of the Orphan School, which formed a model for the later Tasmanian institution.
>
> It was recorded that 'Phlegmatic Paterson,' as he was called, was Lieutenant-Governor at Launceston when Governor Bligh was deposed at Sydney by the New South Wales Corps, and as commanding officer he should have returned to quell the insurrection. But unable to make up his mind which side to support, he remained at Port Dalrymple as long as possible, and when he did assume the command at Sydney his more active confreres carried on the Government. On the arrival of Macquarie, Paterson, together with the other officers, was ordered to England to stand his trial, but he died on the voyage.
>
> Portraits of Governor and Mrs. Macquarie, Captain A. F. Kemp, Lieutenant E. Lord, Bowen, Collins, King, Bligh, Hunter, Banks, and others were exhibited.

6th April, 1936

A meeting was held in the Society's Rooms on this date. In the absence of the President, His Excellency Sir Ernest Clark, K.C.B., C.B.E., Mr. F. E. Ward presided.

It was notified that the new Council had made the following appointments:—Chairman of Council, Mr. W. H. Clemes; Secretary, Dr. J. Pearson; Treasurer, Mr. S. Angel; Standing Committee, Dr. A. N. Lewis, Mr. E. E. Unwin, and the Secretary. Trustees of the Tasmanian Museum and Art Gallery and the Botanical Gardens:—Messrs. Clemes, Unwin, L. M. Shoobridge, M.L.C., and S. Angel, and Drs. W. L. Crowther and A. N. Lewis.

Mr. J. W. Evans, M.A., F.R.E.S., delivered an illustrated lecture on 'The Scope of Applied Entomology,' of which the following is an abstract:—

He said that applied entomology was a science that was concerned with the study of insect pests and their control. Although insects had troubled mankind from time immemorial, it was only during the past 25 years that scientific research had concerned itself with pest control. Applied entomologists were concerned with the following activities:—The prevention of plants and plant products being destroyed in part or totally by insects; the prevention of the access to susceptible crops of insects that transmitted virus diseases; dealing with insects that attacked man and his domestic and domesticated animals and those that were capable of transmitting diseases to man and other animals; and also the prevention of the spread of injurious insects to areas not yet infested by them. The lecturer gave examples of a few entomological problems under each of the above headings. Control measures of insect pests were discussed briefly, and the influence of climate on insects was mentioned. Referring to the biological control of insect pests (control by means of their natural enemies), Mr. Evans maintained that, although such control measures when successful were most spectacular and satisfactory, they would always prove exceptional.

The second half of the lecture consisted of an account of the Thrips problem. He said that there were many kinds of thrips, all of them being small, inconspicuous insects. On the mainland the *Thrips imaginis* was occasionally a serious pest of apple blossom and the flowers of 'soft' fruits. Though not a pest every year, at varying intervals epidemics occurred which resulted in great losses to fruitgrowers. This particular thrips, though present in Tasmania, was never a pest in this State for climatic reasons. The lecturer gave an account of a thrips investigation, which he illustrated with drawings and diagrams, and showed that sufficient data had been obtained to enable the prediction of thrips infestations, and the recommendation of measures for their control.

11th May, 1936

A meeting was held in the Society's Rooms on this date, Mr. F. E. Ward presiding.

Mr. G. V. Brooks, Director of Education, gave an address on 'Observations on Educational Institutions in the United States of America, Canada, England, Scotland, and Ireland,' of which the following is an abstract:—

He said that upon reflection after his return from his trip abroad, and after reading accounts of what others had seen, and comparing them with what he had seen, he had asked himself whether his sampling of schools abroad was sufficiently extensive and thorough to enable him to form any worth-while ideas. The answers varied. For parts of the United States the answer was 'yes'; for Canada, 'perhaps'; for England and Ireland, 'yes'; for Scotland, probably 'no.' The methods used in great cities like Chicago would not apply to Tasmania, and he had therefore gone out into the country to find conditions comparable to those of Tasmania. Attention was being directed to country centres, and something that might fit conditions in Tasmania was being evolved.

At the beginning of the year experiments were made at Sheffield and Hagley. A centre was chosen to serve schools within a radius of 5 or 6 miles. The children were provided with bicycles, and rode to the central town every day. They would spend three years at the centre, and the system was working remarkably well. The type of education was distinctly rural, and the school spirit was fine. The scheme cost less than the high school, and in some ways served the same purpose.

Dealing with library developments and the reading habit applied to schools, Mr. Brooks said that in Hawaii he was struck by the way in which the children were taught how to read and to be at home in a library. In England there was a strong library spirit. In Tasmania too little was done.

Mr. Brooks further discussed modern trends in school-building and methods of management, comparing the centralised system of the Australian States to its advantage with the methods of control in the United States and Canada.

18TH JUNE, 1936

A meeting was held in the Society's Rooms on this date, the President, His Excellency the Governor, presiding.

The following member was elected:—Mr. H. H. Pearce.

Professor F. E. Lloyd, Professor of Botany in the McGill University, Montreal, gave a lecture entitled 'The Carnivorous Plants of the World,' of which the following is an abstract:—

> The Professor, who has made an extensive study of carnivorous plants, stated that Australia was of particular interest in relation to them, as in the Commonwealth, he thought, there were more kinds of these plants than in any other country in the world. He expressed himself a firm believer in the old Chinese proverb: 'A hundred hearings is not as good as one seeing.' Professor Lloyd illustrated his remarks with a series of lantern slides, in which the main features of many of the 450 kinds of plants that capture and digest insects and other such creatures were shown.
>
> The latter portion of the lecture comprised motion pictures of several of the carnivorous plants in actual action, and of the principles on which the main species operate.

13TH JULY, 1936

A meeting was held in the Society's Rooms on this date, the President, His Excellency the Governor, presiding.

Dr. W. Arundel Orchard gave an interesting lecture entitled 'The Evolution of Keyboard Instruments and Their Music,' of which the following is an abstract:—

> Dr. Orchard told how in 1885 the small clay model of an organ with pipes and a keyboard had been discovered among ruins of ancient Carthage. The instrument was made by the Egyptian Ctesipius, and was dated about 320 B.C. The organ appeared to have been used in the church for the first time in Spain, about the fifth century, but without any knowledge of the ancient instrument. It was merely a set of pipes with a slide under each pipe. The keys, about 2 inches wide and 18 inches long, gradually became smaller.
>
> It was not until the thirteenth and fourteenth centuries that one heard of a small keyboard adapted to strings. The first instrument of this type seemed to be the clavichord, the wires whereof were pressed by a brass tangent acted on by a key. The sound was very quiet. One beauty was that as long as one kept a finger on the key the sound continued, so that one could get a "Bebung" or vibrato. Hence the partiality of John Sebastian Bach for the instrument. Many of his famous fugues sounded much better on it than on the modern piano.
>
> The instrument, called in English the virginal and in Italian the spinet, was played in another way. At the end of the key within the instrument was an upright piece of wood known as a jack, tipped with a piece of leather or a quill. The harpsichord had on a larger scale the same action as the virginal. Dr. Orchard gave examples of harpsichord music played by members of the Dolmetsch family, and showed how popular the instruments were in the sixteenth, seventeenth, and eighteenth centuries. Dr. Orchard spoke of the great makers, beginning with Hans Ruckers, of Antwept, and Tschudi (forerunner of Broadwoods), who made magnificent harpsichords.

10TH AUGUST, 1936

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Mr. A. L. Meston gave an interesting lecture entitled 'The Problem of the Tasmanian Aborigine.' (See this volume, p. 85.)

7TH SEPTEMBER, 1936

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The first Clive Lord Memorial Lecture was delivered by Professor L. F. Giblin, D.S.O., M.A., Ritchie Professor of Economics, University of Melbourne. His Excellency the Governor presided, and before the lecture presented the Clive Lord Memorial Medal to Professor Giblin.

Professor Giblin took as his subject a general survey of developments of Tasmanian economy, its present position and prospect. He closely analysed the relative growth of population in Tasmania and the mainland of Australia, with special reference to the industries occupying working groups of various classifications, the indication being that Australia's rate of advance was consistently more rapid than that of Tasmania. As regards occupational activity, Tasmania showed a make-up of population different from the Australian average. It was computed that Tasmania's annual income was about 14 millions, which was offset by the heavy burden of interest on public debt as well as the interest on outside money invested in industrial undertakings. On the other hand, the State benefited to the extent of one million pounds received from the Commonwealth. In 1934-35 Tasmania's imports exceeded her exports by nearly £300,000. The State could not indefinitely go on living on its debts. It was noteworthy that over 90 per cent. of her exports were interstate. Tasmania, therefore, was most inter-dependent of the States of Australia, and, despite her insular position, was more organically a part of Australia than any other State. It followed that prosperity and progress for Tasmania was very closely bound up with the prosperity of Australia as a whole. A view of the State's chief products suggested the same conclusion. There was very little scope for expansion in the wool trade, and, as regards metals, new mining fields of importance were still possible but not very probable.

Tasmania's other important overseas export was apples, of which there was a sorry tale to tell. Over-production had been disastrous, and it would pay Tasmania better to restrict her exports of apples. Everything pointed to the fact that the prosperity of Tasmania was intimately bound up with that of Australia as a whole, and the conclusion was that Tasmania must link itself with Australian development. The lecturer then went on to examine the trade position of Australia as a whole from this point of view.

In conclusion, the lecturer stated that a general increase of world's trade was essential to Australia's industrial development, and there was hope of this. Tasmania should grasp the chance that would present itself in Australia's increased development, but more intelligently organized methods were definitely called for in this direction. Tasmania, therefore, should set herself to study every possibility of increasing her mainland market, and should shape her industries to share the results of Australia's domestic expansion.

12TH OCTOBER, 1936

A meeting was held in the Society's Rooms, Mr. F. E. Ward, in the absence of His Excellency the Governor, presiding.

The following member was elected:—Hon. E. Dwyer-Gray.

The following papers, submitted for the 1936 Papers and Proceedings, were tabled, and referred to the Standing Committee:—

'The Occurrence of Fossil Plants at Warrentinna, Tasmania,' by Isabel C. Cookson, D.Sc.

'Australian Leaf-hoppers (Jassoidea, Homoptera), Part 4,' by J. W. Evans, M.A., F.R.E.S.

'Australian Leaf-hoppers (Jassoidea, Homoptera), Part 5,' by J. W. Evans, M.A., F.R.E.S.

Mr. H. T. Parker delivered a lecture entitled 'The Examiners on the Defensive,' of which the following is an abstract:—

Mr. Parker said examinations were typically authoritarian. The autocracy of the examiner, founded on prestige, probably arose from respect for the exactitude which attached to empirical-mathematical facts. A report was published towards the end of last year by an English committee of inquiry under the chairmanship of Sir Michael Sadler, and including such outstanding educationists as Dr. P. B. Ballard, Dr. C. Spearman, Sir Percy Nunn, and Sir Philip Hartog. The committee gathered actual examination scripts, and had them examined by sets of recognized examiners. They then made comparisons of the results obtained. The marks allotted by examiners for any one paper showed wide discrepancies. When an examiner marked a paper for a second time it was not unusual for him to change his own verdict. But there was a more fundamental question to be faced. How did that which examinations purported to measure agree with the ideal or the actual product of education? Quite commonly they spoke of teachers preparing pupils for examinations; yet every educator knew that such a process was a debasement of the function of the teacher. The examination did not set out to test the result of teaching, but only that examinable part of it which was represented by certain memory and (possibly) intellectual processes. The chief charge against the examiner was that he had undertaken functions which he could by no possibility discharge. These functions had been thrust upon him. But in attempting to discharge them he had essayed the impossible, and so had laid himself open to challenge. Education was concerned with the development of the whole powers of the individual, artistic, intellectual, and social. With the intellectual development alone had the examination any considerable place, and with that, only in respect of what were recognized as its responsive or reactive aspects.

Some points on the other side were that the examiner had no standards to guide him. He was compelled to contrive his own, and was liable to differ from other examiners, and also at times to falter in his own. The limits of his task had not been prescribed. He examined within a certain syllabus, and in self-defence was reduced to observance of the mere letter of a course of instruction. The examiner was forced into a false position by the magnification of his assessment to the relative neglect of other educational outcomes. The examiner was untrained. It was enough for one to be eminent in his profession to be considered eligible as an examiner.

9TH NOVEMBER, 1936

A meeting was held in the Society's Rooms, Mr. V. V. Hickman presiding in the absence of His Excellency the Governor.

The following member was elected:—Mr. J. Burgess Watt.

Dr. W. L. Crowther delivered a lecture entitled 'Sealing in Bass Strait.' (See this volume, p. 79.)

Northern Branch

Annual Report, 1936

The activities of the Northern Branch during 1936 comprised: Annual meeting, followed by public lecture; four monthly meetings (two of them public lectures); six Council meetings.

All meetings were held at the Public Library, Launceston.

12TH MAY, 1936

Annual Meeting

Mr. A. L. Meston presided. The following officials were elected for 1936:—

President: Mr. A. L. Meston.

Council: The President, Hon. Tasman Shields, Mr. W. R. Rolph, Mr. R. S. Padman, Mr. F. Heyward, Mr. D. V. Allen, Mr. J. E. Heritage, Mr. F. Smithies, Mr. J. R. Forward, and the Secretary.

Hon. Secretary: Mr. E. O. G. Scott.

Hon. Auditor: Mr. R. S. Padman.

The statement of accounts, which disclosed a credit balance of £28, was read and adopted.

Public Lecture

The annual meeting was followed at 8 p.m. by a public lecture, 'Heredity, Genetics, and Eugenics,' by Dr. Joseph Pearson, who was introduced by the President. There was an attendance of about 150.

23RD JUNE, 1936

The President, Mr. A. L. Meston, presided.

The meeting took the form of a public lecture, 'The Carnivorous Plants of the World,' by Professor Francis E. Lloyd, McGill University, Montreal. There was an attendance of about 150.

20TH JULY, 1936

The President, Mr. A. L. Meston, presided.

The meeting took the form of a public lecture, 'Hydro-Electric Development in Tasmania,' by Mr. W. E. Maclean, Hydro-Electric Commissioner. There was an attendance of about 200.

24th August, 1936

The President, Mr. A. L. Meston, presided.

Illustrated lecture: 'The Problem of the Tasmanian Aborigine.'

Discussion: Messrs. W. Calver, W. R. Rolph, D. V. Allen, and E. Scott took part in the discussion following the lecture.

28th September, 1936

The President, Mr. A. L. Meston, presided.

Papers:

(*a*) 'The Problem of the Tasmanian Aborigine,' by A. L. Meston, M.A.

(*b*) 'Observations on Some Tasmanian Fishes, Part IV.,' by E. O. G. Scott, B.Sc.

(*c*) 'Observations on Fishes of the Family Galaxiidae, Part II.,' by E. O. G. Scott, B.Sc.

Exhibits: The President exhibited, and gave a short account of, (*a*) a Tasmanian aboriginal drinking-cup, (*b*) a series of Tasmanian pebble-choppers.

Council Meetings

Meetings of the Council were held on 22nd April, 28th May, 10th July, 30th July, 21st September, 10th December.

Walter E. Shimmins, Government Printer, Tasmania.